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Kim et al.

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(54) **ELECTRONIC DEVICE INCLUDING BENT DISPLAY AND METHOD OF DISPLAYING IMAGE ON BENT DISPLAY**

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G06F 3/0488 (2013.01)

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See application file for complete search history.

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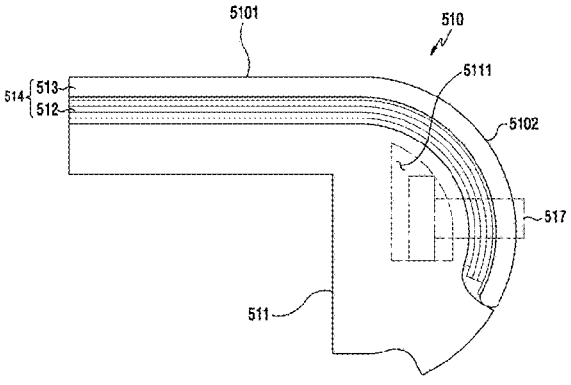
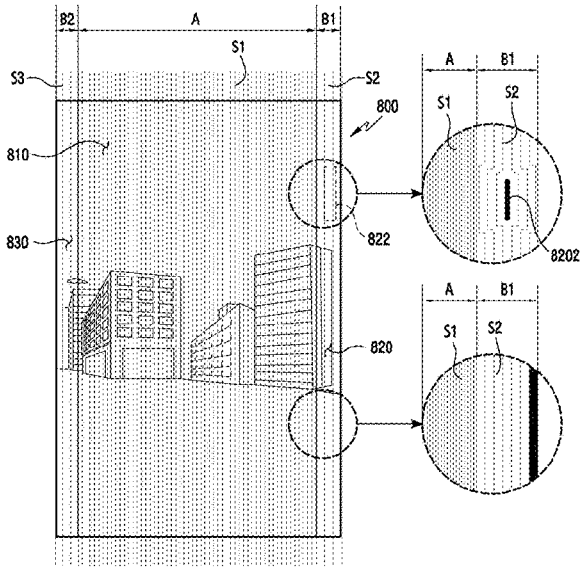
(74) *Attorney, Agent, or Firm* — The Farrell Law Firm, P.C.

(57) **ABSTRACT**

Disclosed is an electronic device including a display for data input/output, a bent display having a bent face formed by bending at least portion of a flat-type display and on which a mounted component is exposed, to provide a unique user experience, pleasing aesthetics, increased user function and improved grip capabilities.

14 Claims, 18 Drawing Sheets





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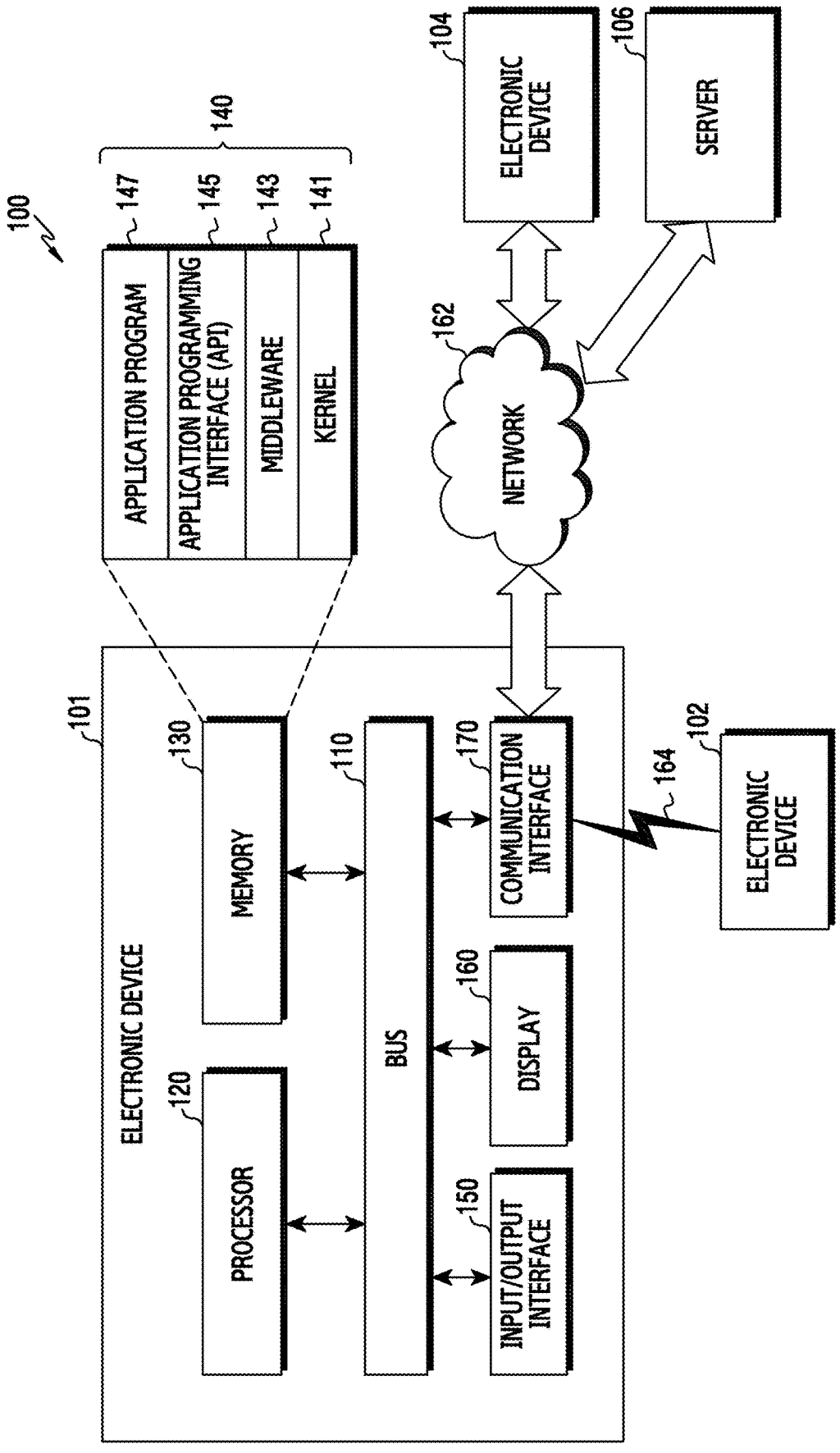
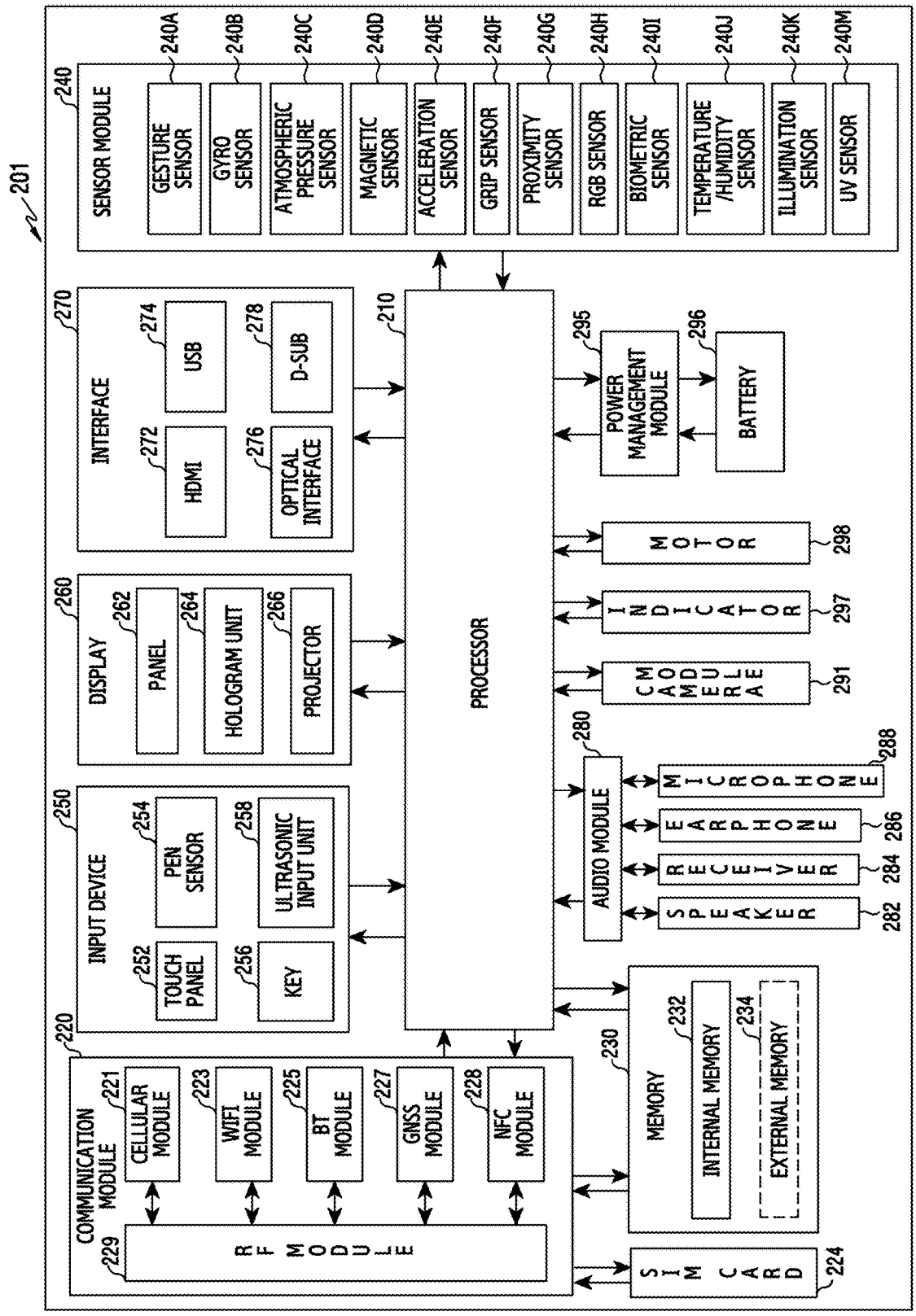

100
140
147
145
143
141
APPLICATION PROGRAM
APPLICATION PROGRAMMING INTERFACE (API)
MIDDLEWARE
KERNEL
104
ELECTRONIC DEVICE
106
SERVER
162
NETWORK
101
ELECTRONIC DEVICE
130
MEMORY
110
BUS
170
COMMUNICATION INTERFACE
164
102
ELECTRONIC DEVICE
120
PROCESSOR
160
DISPLAY
150
INPUT/OUTPUT INTERFACE

FIG. 1


201
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240
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240A
GYRO SENSOR
240B
ATMOSPHERIC PRESSURE SENSOR
240C
MAGNETIC SENSOR
240D
ACCELERATION SENSOR
240E
GRIP SENSOR
240F
PROXIMITY SENSOR
240G
RGB SENSOR
240H
BIOMETRIC SENSOR
240I
TEMPERATURE /HUMIDITY SENSOR
240J
ILLUMINATION SENSOR
240K
UV SENSOR
240M
INTERFACE
270
USB
274
D-SUB
278
HDMI
272
OPTICAL INTERFACE
276
DISPLAY
260
PANEL
262
HOLOGRAM UNIT
264
PROJECTOR
266
INPUT DEVICE
250
PEN SENSOR
254
ULTRASONIC INPUT UNIT
258
TOUCH PANEL
252
KEY
256
COMMUNICATION MODULE
220
CELLULAR MODULE
221
WIFI MODULE
223
BT MODULE
225
GNSS MODULE
227
NFC MODULE
228
RF MODULE
229
PROCESSOR
210
POWER MANAGEMENT MODULE
295
BATTERY
296
MOTOR
298
INDICATOR
297
CAMERA MODULE
291
AUDIO MODULE
280
MICROPHONE
288
RECEIVER PHONE
286
SPEAKER
284
SPEAKER
282
MEMORY
230
INTERNAL MEMORY
232
EXTERNAL MEMORY
234
SIM CARD
224

FIG.2

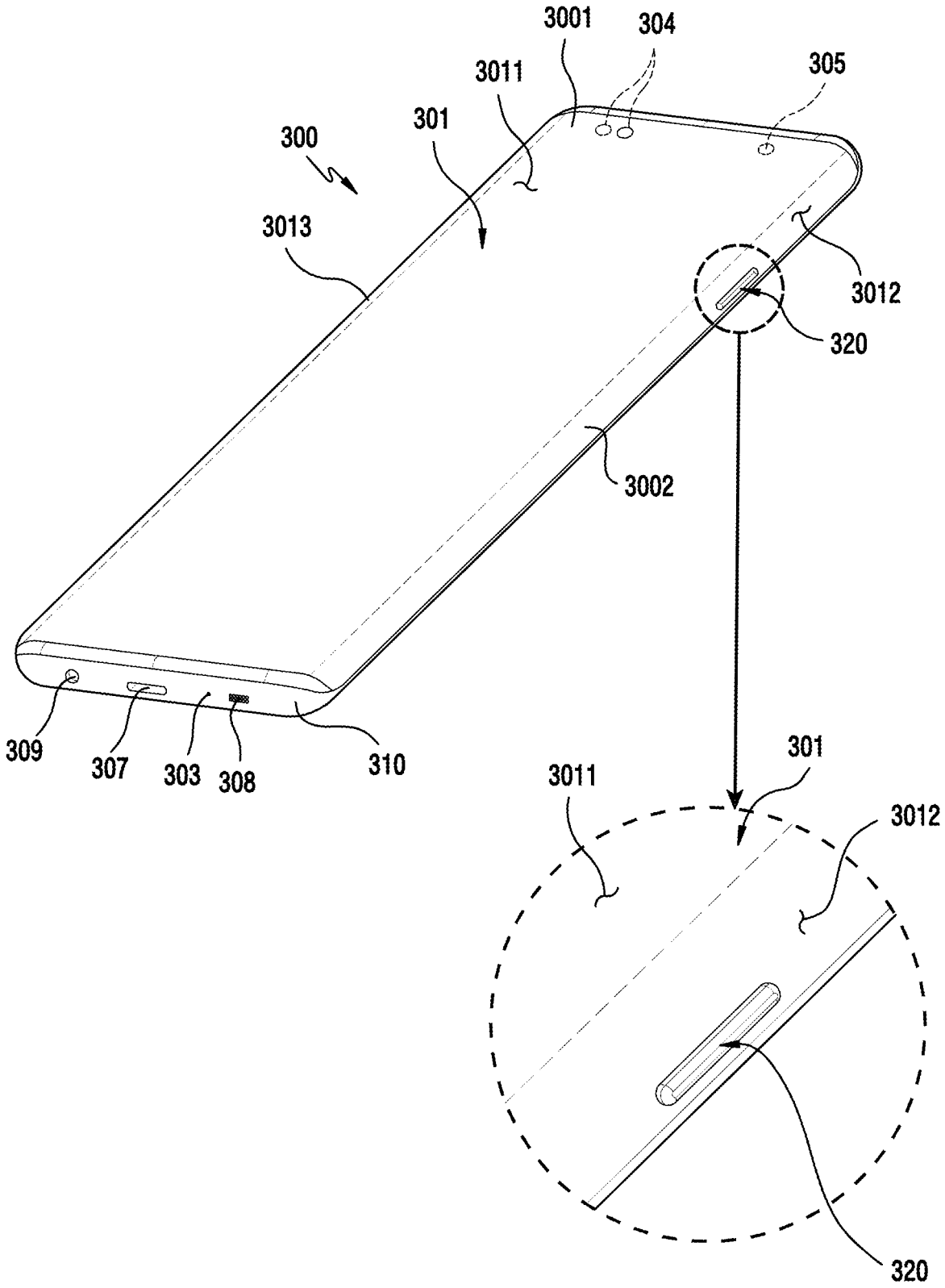
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FIG.3A

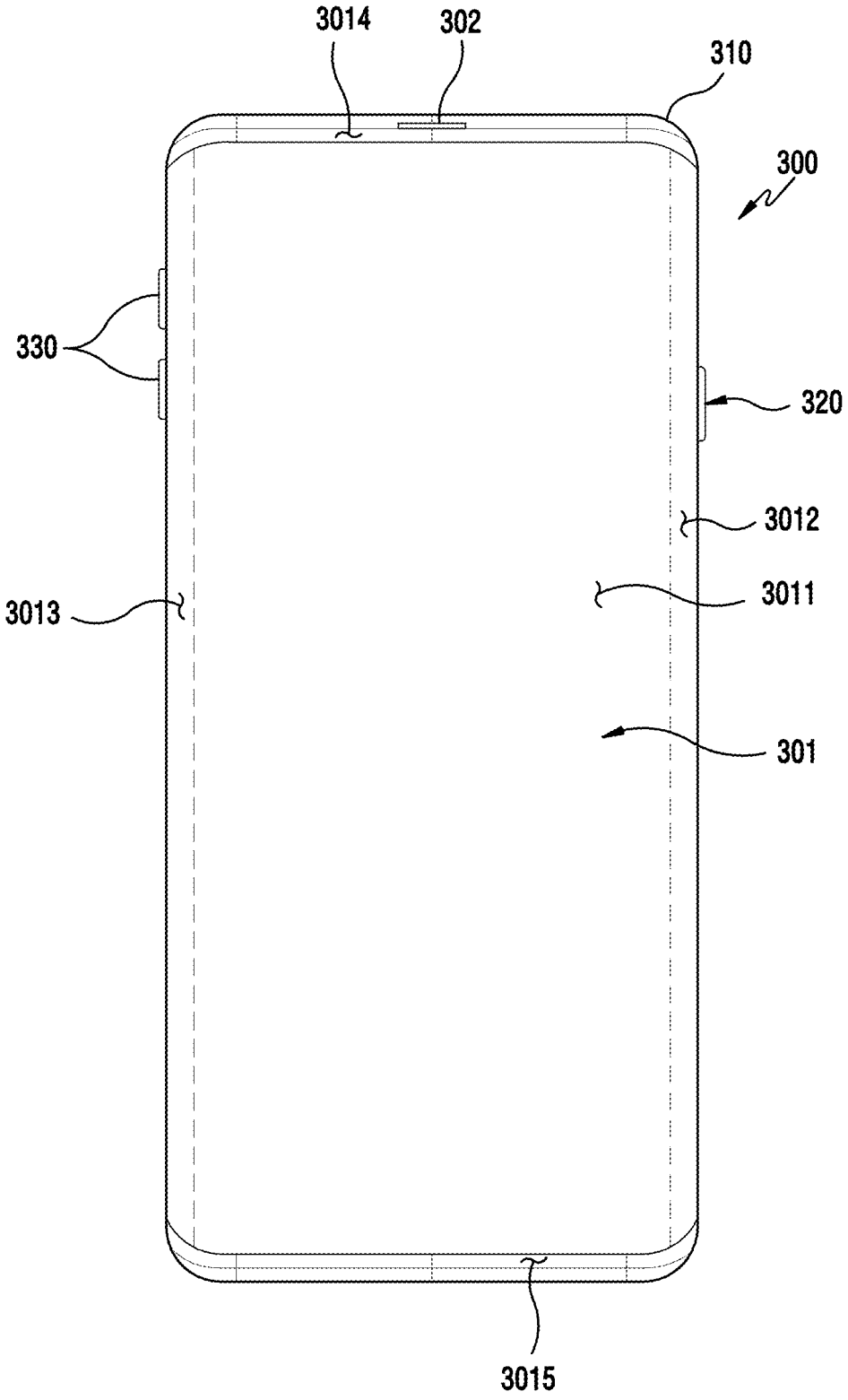


FIG.3B

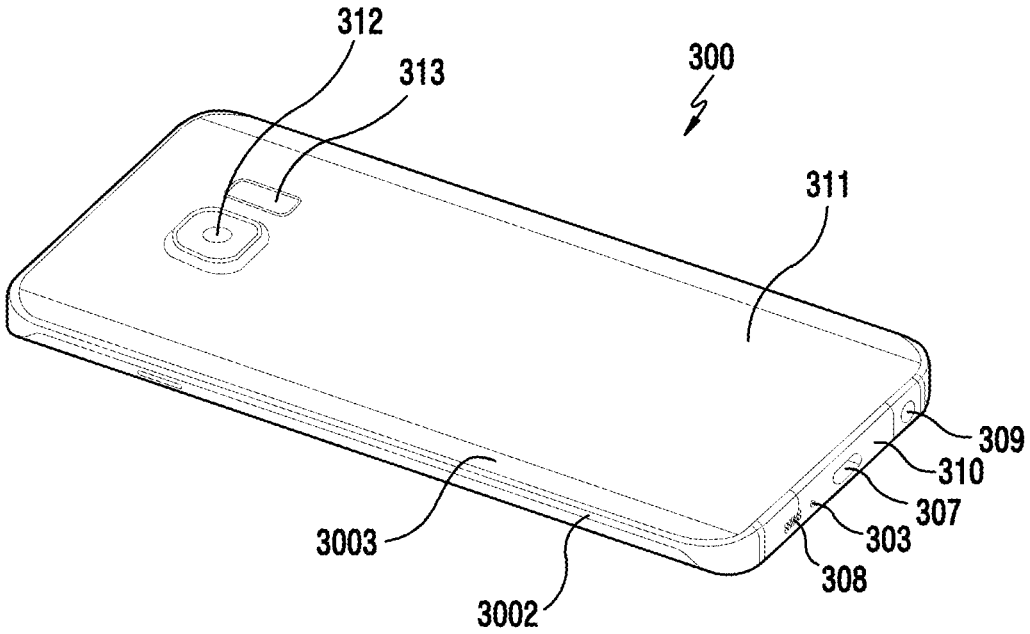
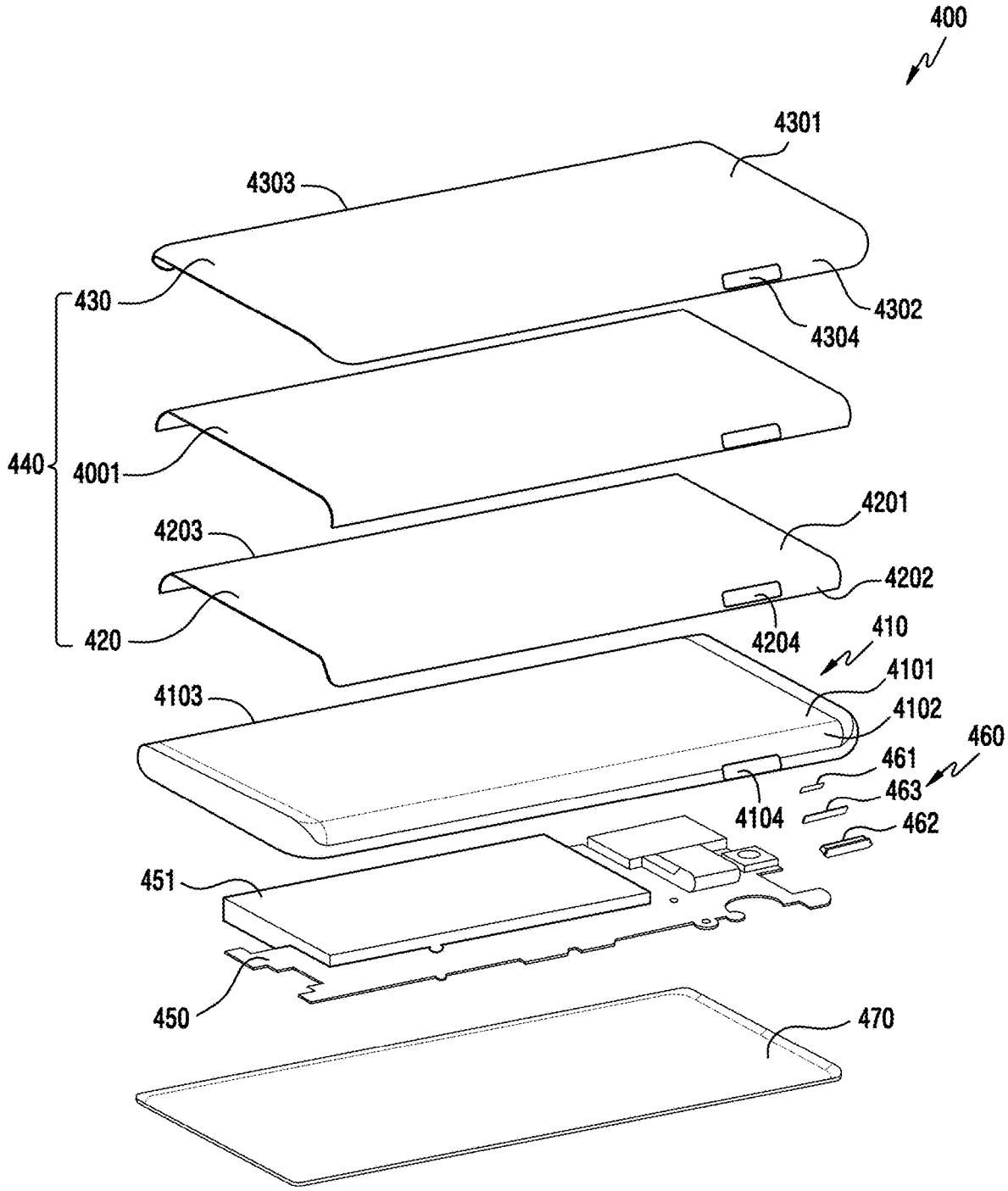


FIG.3C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4104
462
451
450
470

FIG.4

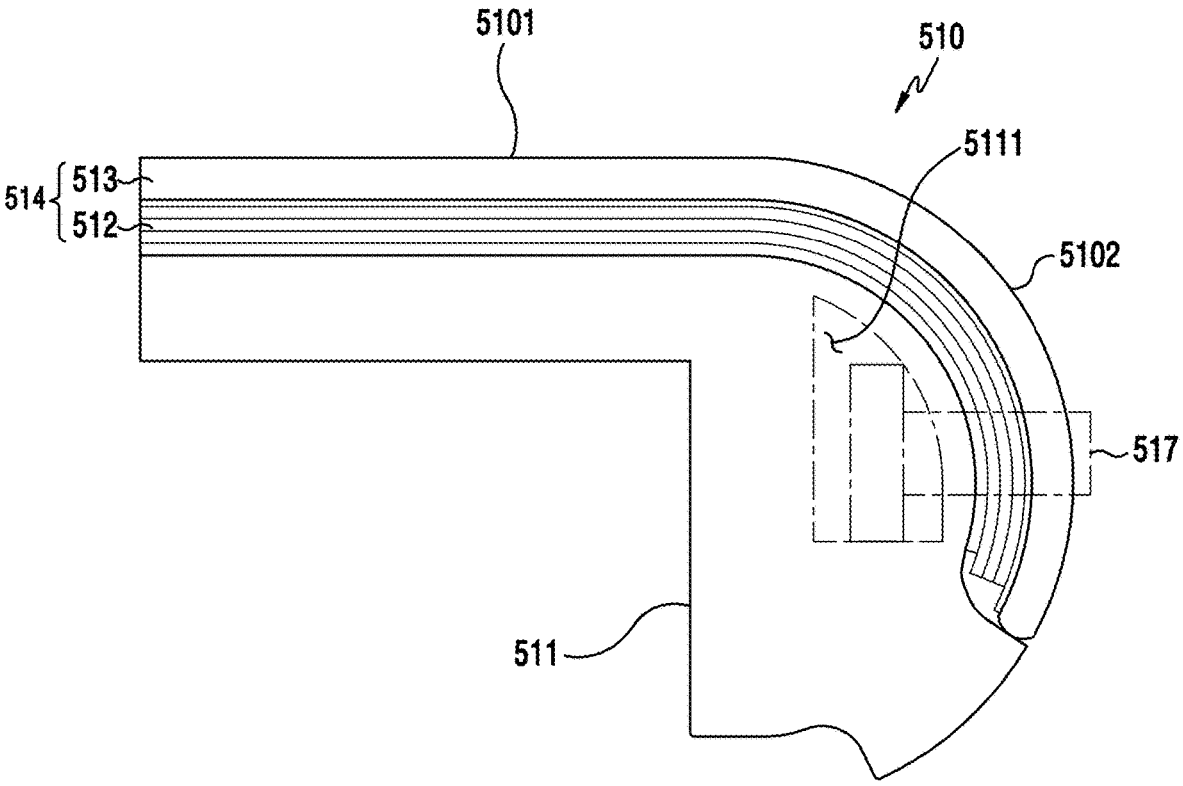


FIG.5A

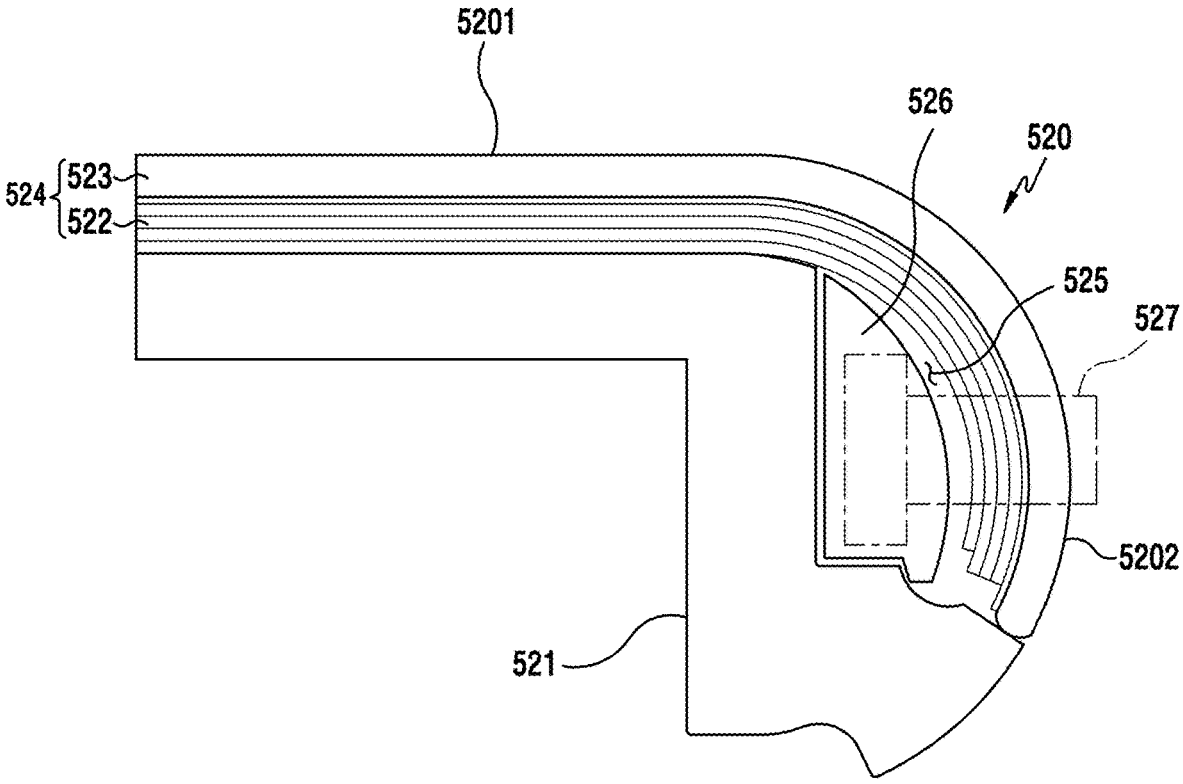
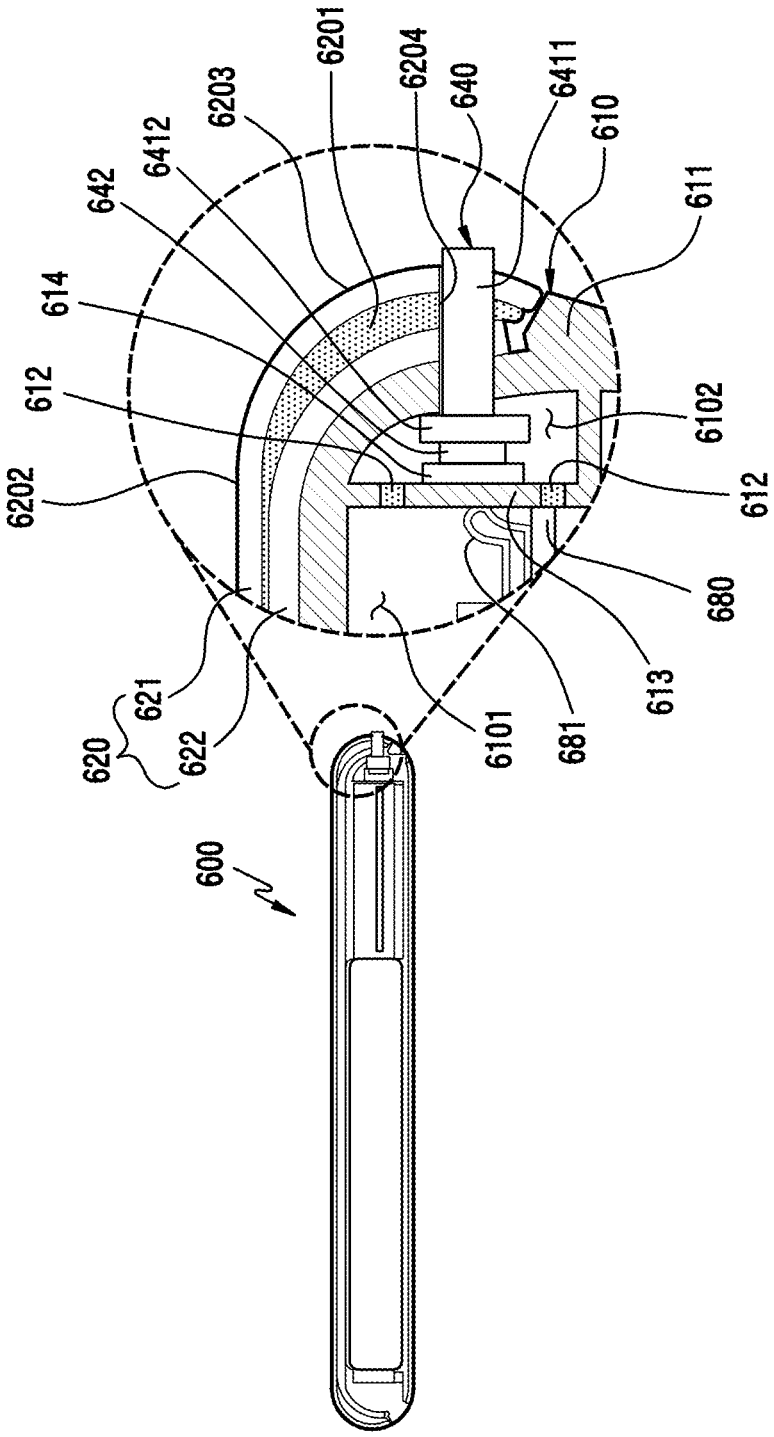


FIG.5B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6202
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621
620
622
6101
681
600

FIG.6A

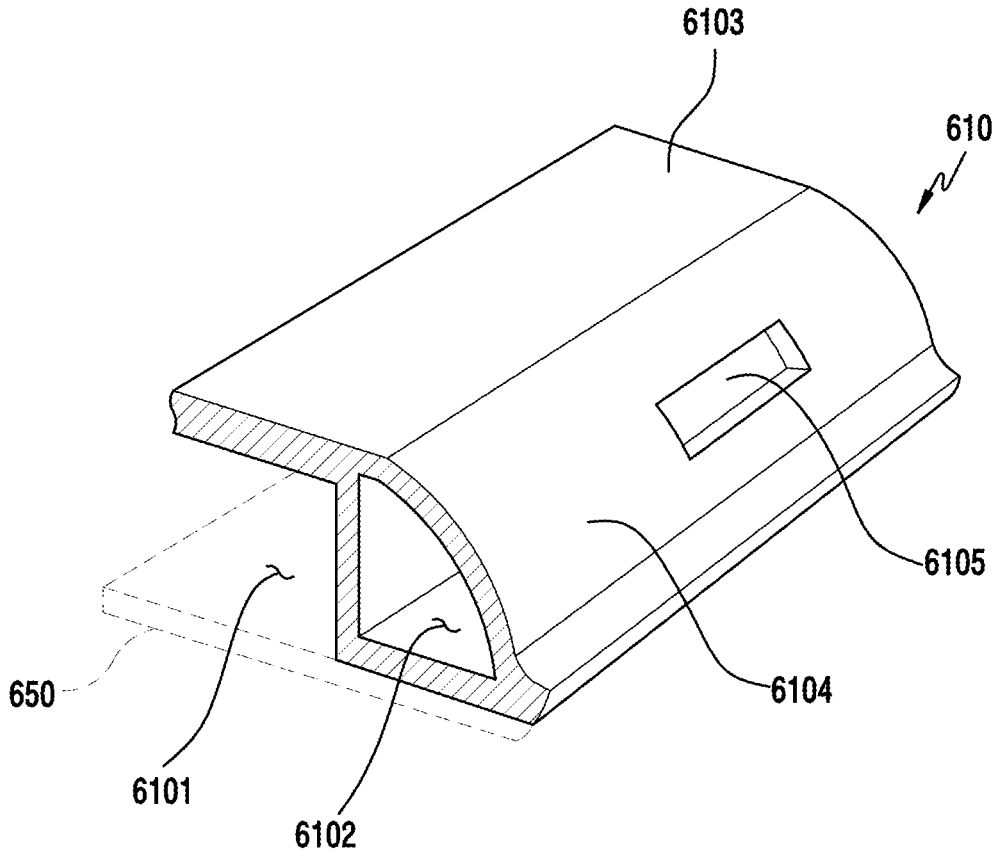

FIG.6B

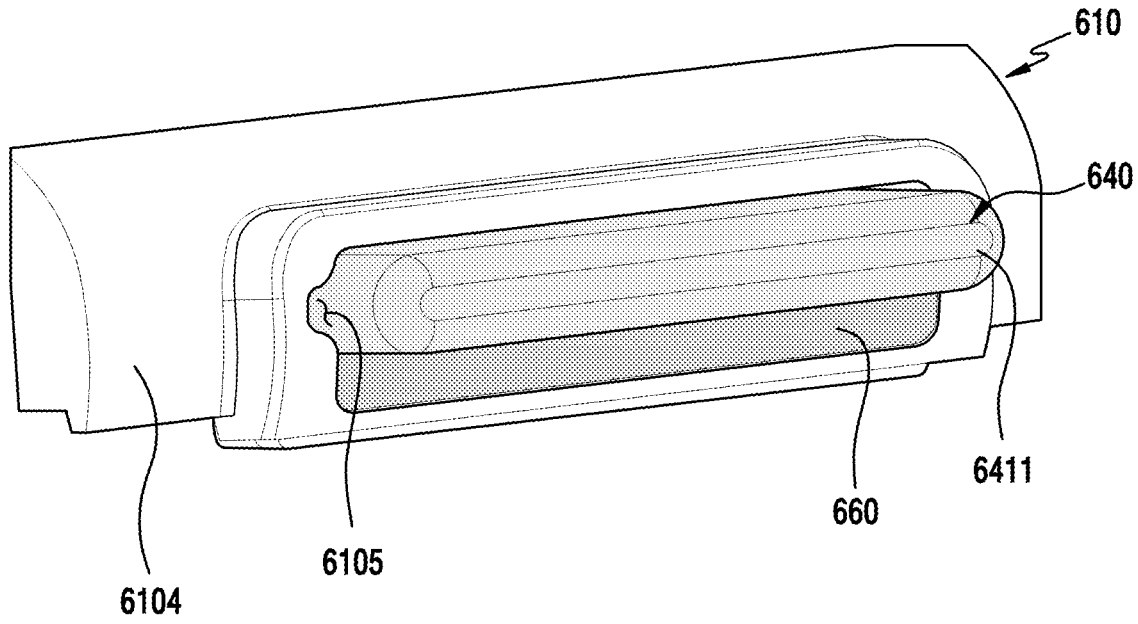

FIG.6C

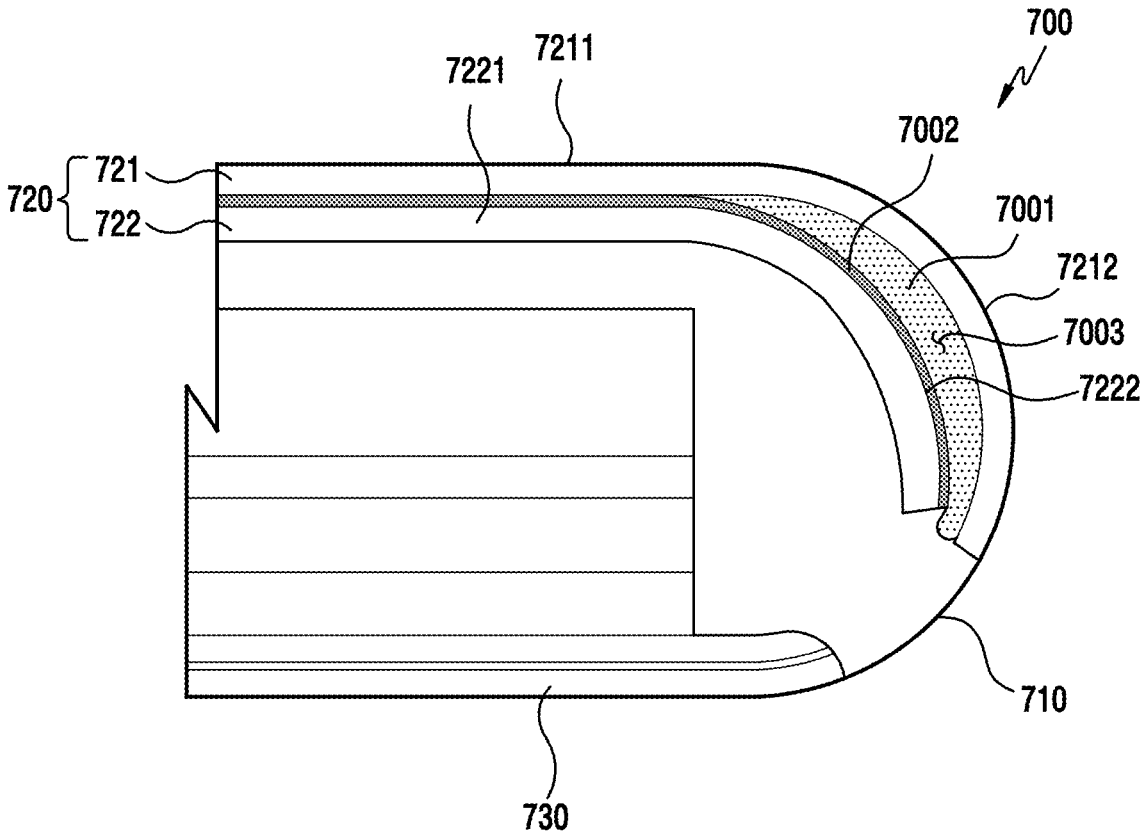

FIG.7A

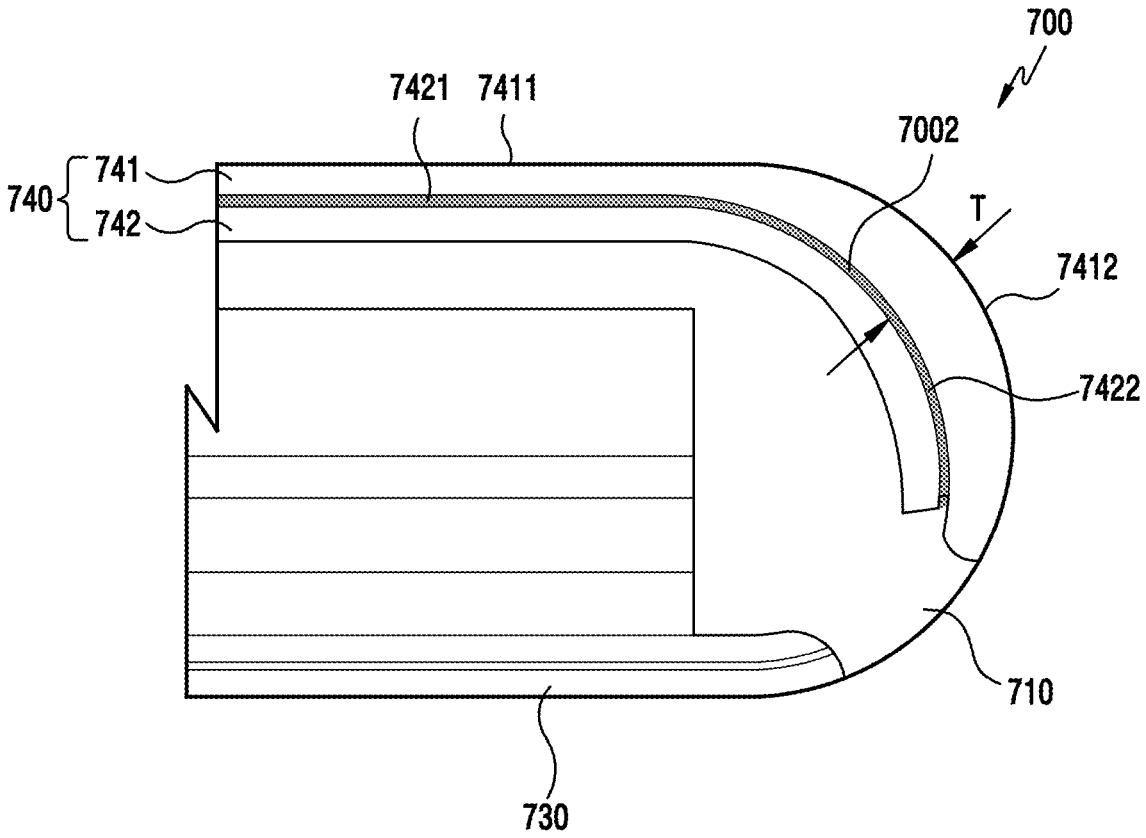

FIG.7B

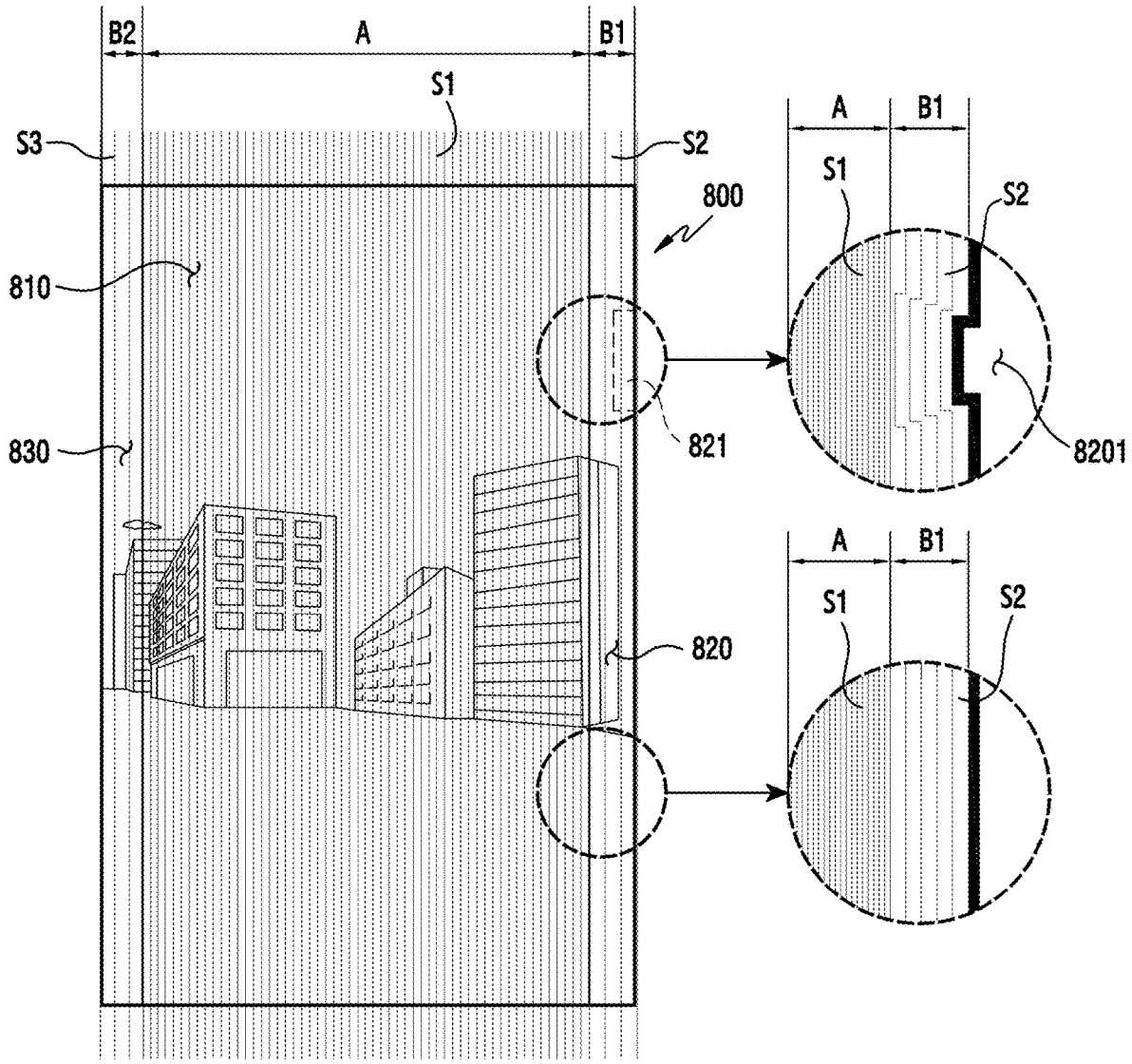

FIG.8A

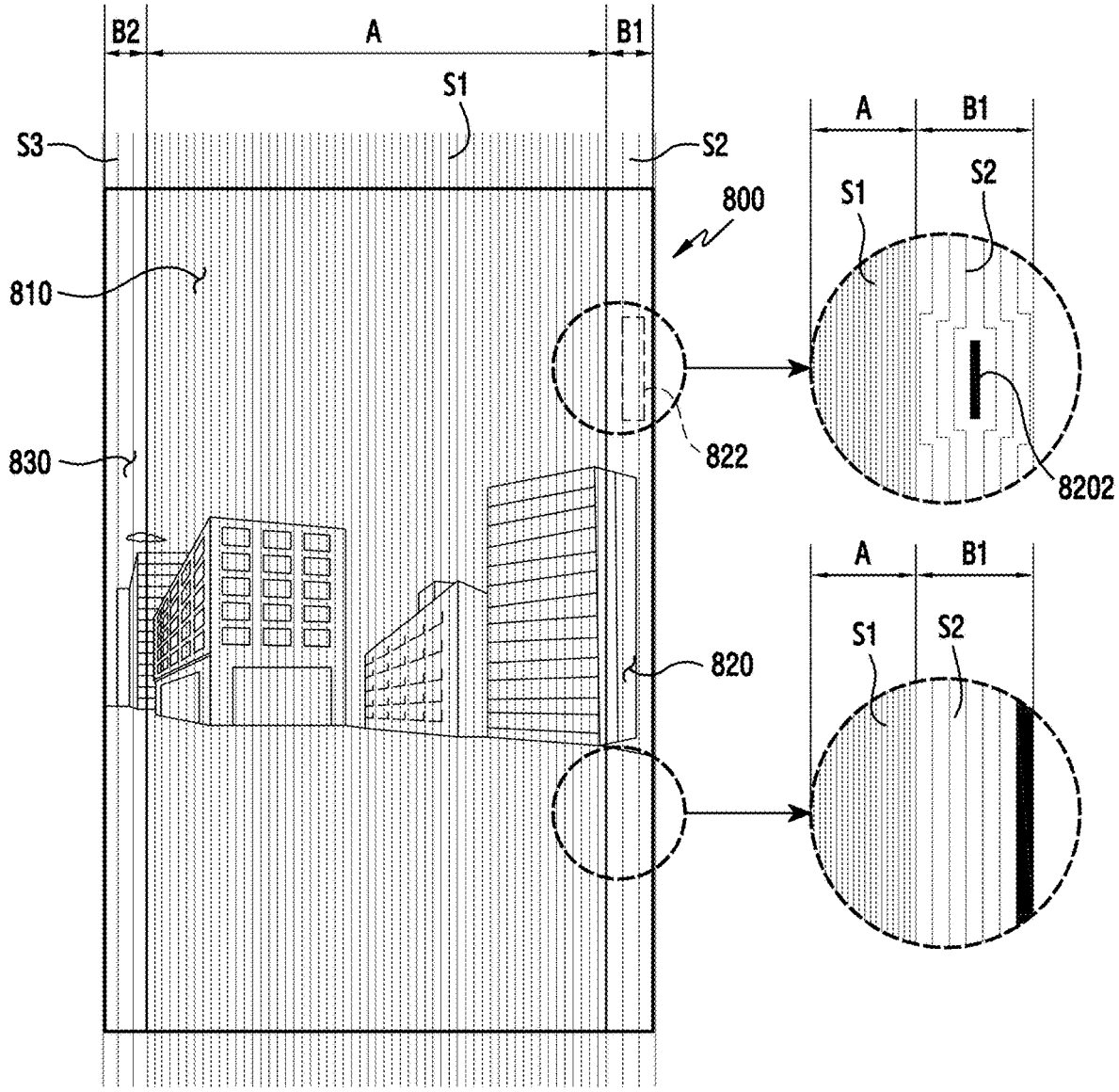

FIG.8B

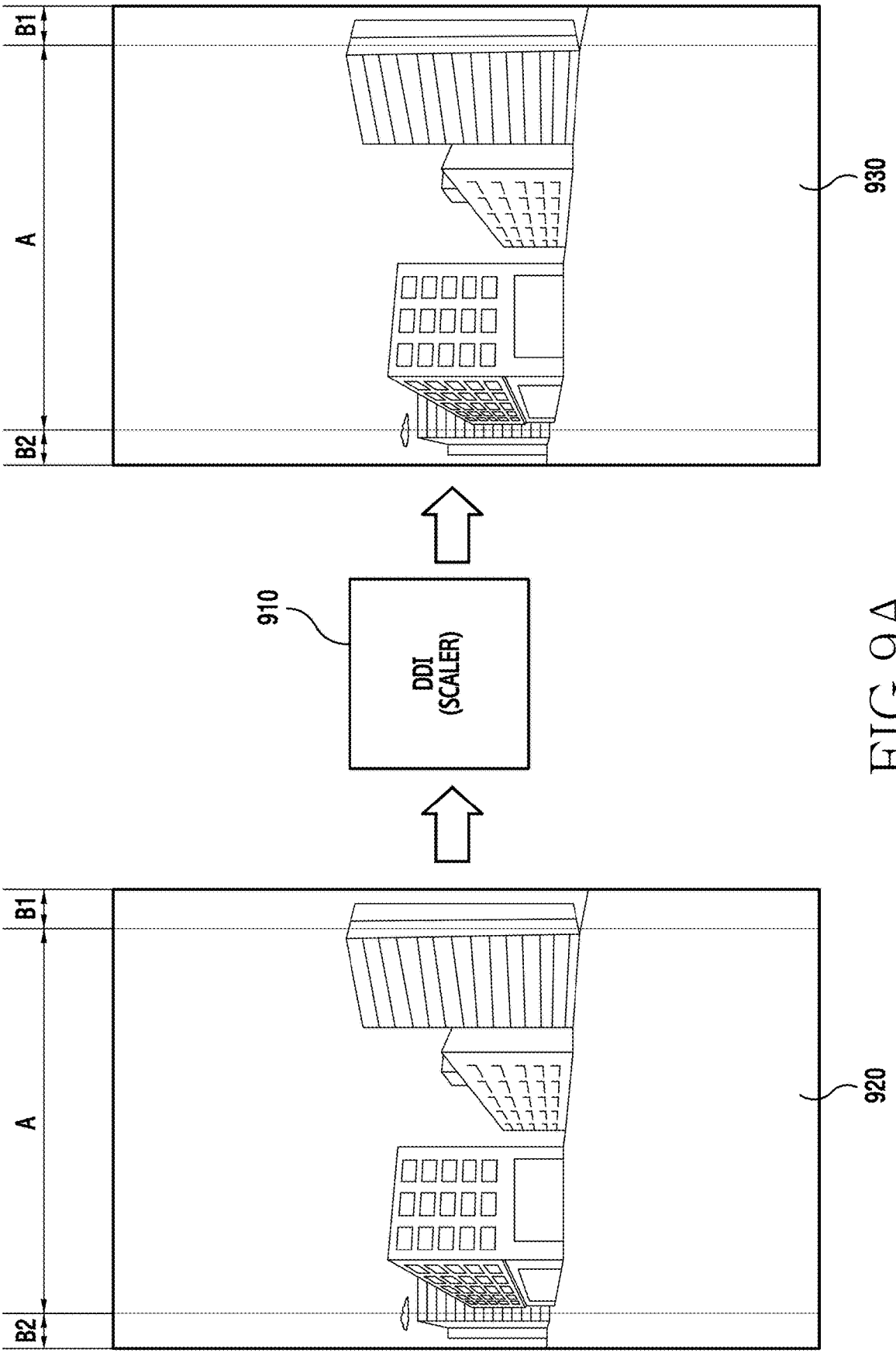

FIG.9A

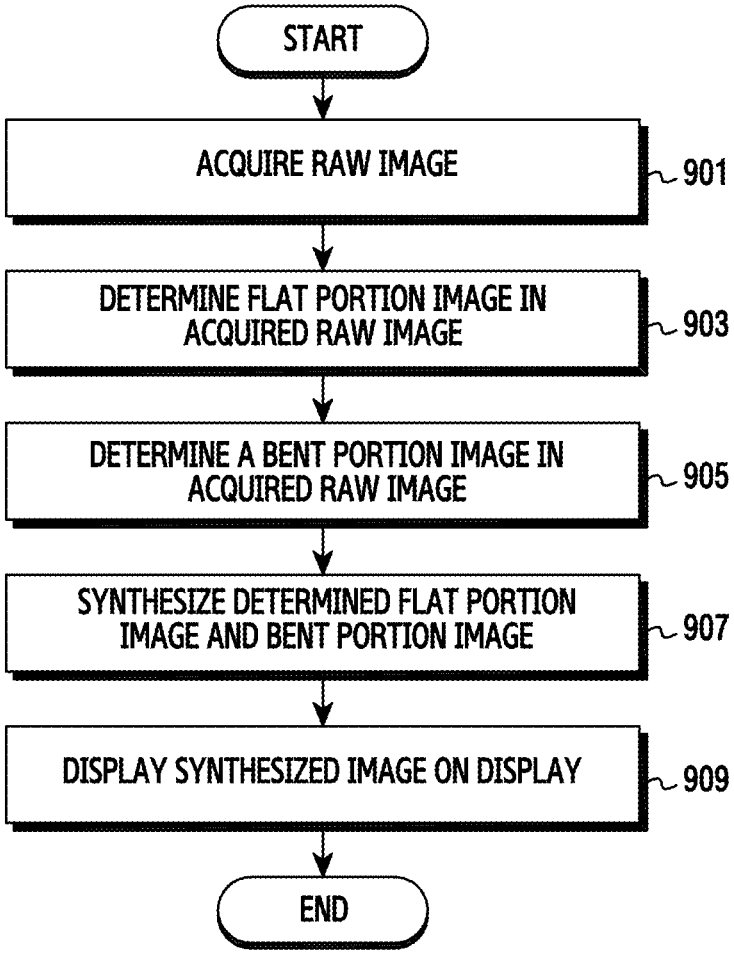
START
ACQUIRE RAW IMAGE
901
DETERMINE FLAT PORTION IMAGE IN ACQUIRED RAW IMAGE
903
DETERMINE A BENT PORTION IMAGE IN ACQUIRED RAW IMAGE
905
SYNTHESIZE DETERMINED FLAT PORTION IMAGE AND BENT PORTION IMAGE
907
DISPLAY SYNTHESIZED IMAGE ON DISPLAY
909
END

FIG.9B

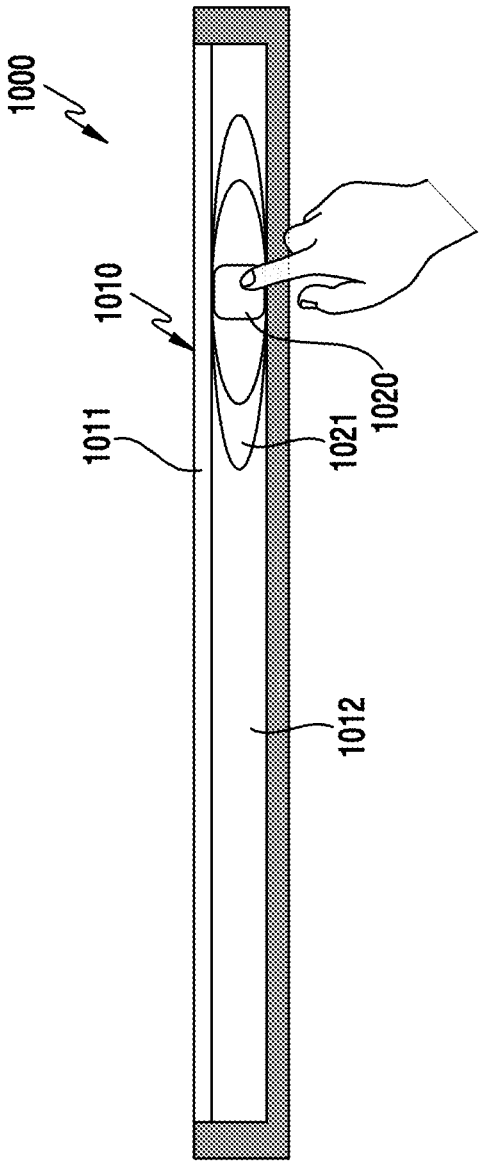

FIG. 10

ELECTRONIC DEVICE INCLUDING BENT DISPLAY AND METHOD OF DISPLAYING IMAGE ON BENT DISPLAY

PRIORITY

This application claims priority under 35 U.S.C. § 119(a) to a Korean Patent Application which was filed in the Korean Intellectual Property Office on Feb. 28, 2017 and assigned Serial No. 10-2017-0026133, the contents of which are incorporated herein by reference.

BACKGROUND

1. Field of the Disclosure

The present disclosure relates generally to an electronic device, and more particularly, to an electronic device including a bent display, and a method of displaying an image on the bent display.

2. Description of the Related Art

Portable electronic devices, particularly smart phones, have become increasingly sophisticated, and hardware/software disparities between manufacturers are gradually decreasing. As a result, performance and design of electronic devices are steadily improving.

A bent display applied to an electronic device may include a bent region extending from a front region of the electronic device to a portion of a side face or a rear face through the side face. In such an electronic device, however, inconvenience is caused by the exclusion of a side key button that is typically disposed on a side face, due to the enlargement of the display region.

Furthermore, the inclusion of a non-protruding button such as a touch button implemented by a pressure sensor, is not intuitively provided to the user, and thus does not sufficiently replace the side key button.

As such, there exists a need in the art for an electronic device that improves the appearance and handling for the user.

SUMMARY

Aspects of the present disclosure are to address at least the above mentioned problems and/or disadvantages and to provide at least the advantages described below.

Accordingly, an aspect of the present disclosure is to provide, in an electronic device including a display for data input/output, a bent display having a bent face formed by bending at least portion of a flat-type display and on which a mounted component is exposed, to provide a unique user experience, pleasing aesthetics, increased user function and improved grip capabilities.

According to an aspect of the present disclosure, there is provided an electronic device including a housing including a first face, a second face facing away from the first face, and a side face surrounding a space between the first face and the second face, a display mounted on the housing and including a flat portion substantially corresponding to the first face and a bent portion extending in a lateral direction from the flat portion, at least one input unit disposed between the bent portion of the display and the housing and at least partially exposed outwardly through at least a portion of the bent portion, a detection circuit disposed inside the housing and electrically connected to the input unit, the detection circuit being configured to detect an operation of the at least one input unit, and at least one processor functionally connected to the detection circuit and the display and configured to perform control causing the electronic device to perform a corresponding function according to a received detection signal, wherein an interval between unit signal lines in a plurality of first signal lines arranged on the flat portion of the display is different from an interval between unit signal lines in a plurality of second signal lines disposed in the bent portion.

According to another aspect of the present disclosure, there is provided a method of displaying an image of an electronic device that includes a display having a flat portion and at least one bent portion bent from the flat portion with a predetermined curvature, the method including acquiring a raw image corresponding to an entire region of the display, determining a first image corresponding to the flat portion in the acquired raw image, determining a second image corresponding to the bent portion in the acquired raw image, optimizing the determined first image and second image, and displaying an optimized image on the display.

According to another aspect of the present disclosure, there is provided an electronic device including a display formed in at least a portion of the electronic device, and including a first region and a second region bent at a designated angle from the first region, an input unit configured to sense a user input through an opening formed in at least a portion of the second region of the display, and a bracket in which at least a portion of the input unit is functionally connected to a control circuit.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other aspects, features, and advantages of the present disclosure will be more apparent from the following detailed description taken in conjunction with the accompanying drawings, in which:

FIG. **1** illustrates a network environment that includes an electronic device according to embodiments of the present disclosure;

FIG. **2** illustrates a block diagram of an electronic device according to embodiments of the present disclosure;

FIG. **3**A is a perspective view of an electronic device according to embodiments of the present disclosure;

FIG. **3**B is a plan view of the electronic device according to embodiments of the present disclosure;

FIG. **3**C is a rear side perspective view of the electronic device according to embodiments of the present disclosure;

FIG. **4** is an exploded perspective view of an electronic device according to embodiments of the present disclosure;

FIGS. **5**A and **5**B illustrate when an input unit is applied to a bent display according to embodiments of the present disclosure;

FIG. **6**A is a cross-sectional view of an electronic device, to which an input unit according to embodiments of the present disclosure is applied;

FIG. **6**B is a perspective view of a main part, which illustrates the configuration of the housing of FIG. **6**A, according to embodiments of the present disclosure;

FIG. **6**C is a perspective view illustrating when an input unit is mounted on the housing of FIG. **6**A, according to embodiments of the present disclosure;

FIGS. **7**A and **7**B are cross-sectional views of a main part, which illustrates the assembly state of a display according to embodiments of the present disclosure;

FIGS. **8**A and **8**B are configuration views of a display module illustrating the arrangement of signal lines according to the arrangement of an input unit according to embodiments of the present disclosure;

FIG. **9**A illustrates an image optimization process by a display driver integrated circuit (DDI) according to embodiments of the present disclosure;

FIG. **9**B illustrates a procedure for displaying an image through a flat portion and a bent portion of a display according to embodiments of the present disclosure; and

FIG. **10** illustrates a state when various visual objects are applied around a key button through a display according to embodiments of the present disclosure.

DETAILED DESCRIPTION

Embodiments of the present disclosure will now be described in greater detail with reference to the accompanying drawings. In the following disclosure, specific details such as detailed configuration and components are merely provided to assist the overall understanding of the present disclosure. Therefore, it should be apparent to those skilled in the art that various changes and modifications of the embodiments described herein can be made without departing from the present disclosure. For example, those skilled in the art will understand that the principles of the present disclosure may be implemented in any suitably arranged electronic device.

In addition, descriptions of well-known functions and implementations may be omitted for the sake of clarity and conciseness.

The terms and words used in the following description and claims are not limited to their dictionary meanings, but are used to convey a clear and consistent understanding of the present disclosure. Accordingly, it should be apparent to those skilled in the art that the following description of embodiments of the present disclosure is provided for illustrative purposes only and not for the purpose of limiting the present disclosure.

Singular terms such as "a," "an," and "the" include plural references unless the context clearly dictates otherwise. Thus, "a component surface" includes reference to one or more of such surfaces.

Herein, expressions such as "have," "may have," "include," and "may include" indicate the presence of corresponding elements, such as numerical values, functions, operations, or parts, but do not preclude the presence of additional features.

The expressions "A or B," "at least one of A or/and B," and "one or more of A or/and B" include all possible combinations of the enumerated items, i.e., indicates (1) at least one A, (2) at least one B, or (3) at least one A and at least one B.

Numerical terms such as "first" and "second" may modify various elements regardless of an order and/or importance of the elements, and do not limit the elements. These terms may be used for the purpose of distinguishing one element from another element. For example, a first user device and a second user device may indicate different user devices, regardless of the order or importance the devices. Accordingly, a first element may be referred to as a second element, and similarly, a second element may be referred to as a first element, without departing from the present disclosure.

When an element, such as a first element, is "(operatively or communicatively) coupled with/to" or "connected to" another element, such as a second element, the first element may be directly coupled with/to the second element, or there may be an intervening element, such as a third element, between the first and second elements. However, when the first element is "directly coupled with/to" or "directly connected to" the second element, there is no intervening third element.

Herein, the term "module" may refer to a unit including one of hardware, software, and firmware, or any combination thereof, and may be interchangeably used with terms, such as unit, logic, logical block, component, and circuit. A module may be a minimum unit of an integrally constituted component or may be a part thereof, may be a minimum unit for performing one or more functions or may be a part thereof, and may be mechanically or electrically implemented. For example, a module may include at least one of a dedicated processor, a central processing unit (CPU), an application-specific integrated circuit (ASIC) chip, a field-programmable gate array (FPGA), and a programmable-logic device, which are known or will be developed in the future.

All of the terms used herein, including technical or scientific terms, have the same meanings as those generally understood by a person having ordinary skill in the related art unless they are defined otherwise. Terms defined in a generally used dictionary should be interpreted as having the same or similar meanings as the contextual meanings of the relevant technology and should not be interpreted as having ideal or exaggerated meanings unless clearly defined as such herein. Even terms defined in the disclosure should not be interpreted as excluding embodiments of the present disclosure.

Example electronic devices may include smart phones, tablet personal computers (PCs), mobile phones, video telephones, electronic book readers, desktop personal computers, laptop personal computers, netbook computers, workstations, servers, personal digital assistants (PDAs), portable multimedia players (PMPs), motion picture experts group (MPEG-1 or MPEG-2) audio layer 3 (MP3) players, mobile medical devices, cameras, and/or wearable devices, but are not limited thereto.

The wearable devices may include accessory-type wearable devices, such as watches, rings, bracelets, anklets, necklaces, glasses, contact lenses, or head-mounted-devices (HMDs), fabric or clothing integral wearable devices including electronic clothes, body-mounted wearable devices including skin pads or tattoos, and/or implantable wearable devices, but are not limited thereto.

The electronic devices may include smart home appliances, such as televisions (TVs), digital versatile disk (DVD) players, audio players, refrigerators, air conditioners, cleaners, ovens, microwave ovens, washing machines, air cleaners, set-top boxes, home automation control panels, security control panels, TV boxes such as Samsung HomeSync™, Apple TV™, or Google TV™, game consoles such as Xbox™ and PlayStation™, electronic dictionaries, electronic keys, camcorders, and/or electronic picture frames, but are not limited thereto.

The electronic devices may include various portable medical measurement devices, such as blood glucose meters, heart rate monitors, blood pressure monitors, and thermometers, magnetic resonance angiography (MRA) devices, magnetic resonance imaging (MRI) devices, computed tomography (CT) devices, scanners, ultrasonic devices, etc., navigation devices, GPS receivers, event data recorders (EDRs), flight data recorders (FDRs), vehicle infotainment devices, electronic equipment for vessels, such as navigation systems and gyrocompasses, avionics, security devices, head units for vehicles, industrial or home robots, automated teller machines (ATMs), point of sales (POS) devices, and/or Internet of Things (IoT) devices, such as

light bulbs, sensors, electric or gas meters, sprinkler devices, fire alarms, thermostats, street lamps, toasters, exercise equipment, hot water tanks, heaters, and boilers, but are not limited thereto.

The electronic devices may also include parts of furniture or buildings/structures, electronic boards, electronic signature receiving devices, projectors, or water meters, electricity meters, gas meters, and wave meters, may be flexible electronic devices, and may be combinations of the above-described devices but are not limited thereto, and thus may include new electronic devices according to the development of new technologies.

Herein, the term "user" may refer to a person who uses an electronic device or to an artificial intelligence (AI) electronic device which uses an electronic device.

FIG. **1** illustrates a network environment **100** including an electronic device, according to an embodiment of the present disclosure.

Referring to FIG. **1**, the network environment **100** includes an electronic device **101** having a bus **110**, a processor **120**, a memory **130**, an input/output interface **150**, a display **160**, and a communication interface **170**, each of which including accompanying circuitry. Alternatively, the electronic device **101** may omit at least one of the illustrated components and/or include additional components.

The bus **110** may include a circuit for connecting the components and delivering communications such as a control message therebetween.

The processor **120** includes various processing circuitry, such as a dedicated processor, a central processing unit (CPU), an application processor (AP), and/or a communication processor (CP), and processes an operation or data on control of and/or communication with another component of the electronic device **101**.

The processor **120** may also include a microprocessor or any suitable type of processing circuitry, such as one or more general-purpose processors, such as advanced reduced instruction set computer machine (ARM)-based processors, a digital signal processor (DSP), a programmable logic device (PLD), an ASIC, a field-programmable gate array (FPGA), a graphical processing unit (GPU), and a video card controller. In addition, when a general purpose computer accesses code for implementing the processing shown herein, the execution of the code transforms the general purpose computer into a special purpose computer for executing the processing shown herein.

The processor **120**, which can be connected to a long term evolution (LTE) network, may determine whether a call is connected over a circuit switched (CS) service network using caller identification information, such as a caller phone number of the CS service network, which may be a 2nd generation (2G) or a 3rd generation (3G) network. For example, the processor **120** receives incoming call information, such as a CS notification message or a paging request message of the CS service network over the LTE network, such as circuit-switched fallback (CSFB), and receives incoming call information, such as a paging request message over the CS service network, which may be a single radio LTE (SRLTE) network.

When receiving an incoming CS notification message or a paging request message of the CS service network over the LTE network, the processor **120** may obtain caller identification information from the incoming call information, display the caller identification information on the display **160**, and determine whether to connect the call based on input information corresponding to the caller identification information displayed on the display **160**.

For example, when detecting input information corresponding to an incoming call rejection, through the input/output interface **150**, the processor **120** may restrict the voice call connection and maintain the LTE network connection. When detecting input information corresponding to an incoming call acceptance, through the input/output interface **150**, the processor **120** may connect the voice call by connecting to the CS service network.

When receiving the incoming CS notification message or a paging request message of the CS service network over the LTE network, the processor **120** may obtain caller identification information from the incoming call information, and determine whether to connect the call by comparing the caller identification information with a reception control list. For example, when the caller identification information is included in a first reception control list, such as a blacklist, the processor **120** may restrict the voice call connection and maintain the connection to the LTE network. When the caller identification information is not included in the blacklist but is included in a second reception control list, such as a white list, the processor **120** may connect the voice call by connecting to the CS service network.

When receiving the incoming call information, such as a paging request message of the CS service network over the LTE network, the processor **120** may send an incoming call response message, such as a paging response message, to the CS service network, may suspend the LTE service and receive the caller identification information, such as a circuit-switched call (CC) setup message, from the CS service network, and may determine whether to connect the call by comparing the caller identification information with the reception control list.

For example, when the caller identification information is included in the blacklist, the processor **120** restricts the voice call connection and resumes the LTE network connection. When the caller identification information is not included in the blacklist but is included in the white list, the processor **120** may connect the voice call by connecting to the CS service network.

The memory **130** may include volatile and/or nonvolatile memory, may store commands or data, such as the reception control list relating to at least another component of the electronic device **101**, and may store software and/or a program **140** including a kernel **141**, middleware **143**, an application programming interface (API) **145**, and/or application programs (or applications) **147**, at least two of which being referred to as an operating system (OS).

The kernel **141** may control or manage system resources, such as the bus **110**, the processor **120**, or the memory **130** used for performing an operation or function implemented by the other programs, such as the middleware **143**, the API **145**, or the applications **147**, and may provide an interface through which the middleware **143**, the API **145**, or the applications **147** connect the individual elements of the electronic device **101** to control or manage the system resources.

The middleware **143** may function as an intermediary for the API **145** or the applications **147** to communicate with the kernel **141** and exchange data, and may process one or more task requests received from the applications **147** according to priorities thereof For example, the middleware **143** assigns priorities for using the system resources of the electronic device **101**, to at least one of the applications **147**, and performs scheduling or load balancing on the one or more task requests by processing the one or more task requests according to the priorities assigned thereto.

The API **145** is an interface through which the applications **147** may control functions provided from the kernel **141** or the middleware **143**, and may include at least one interface or function, such as an instruction for file control, window control, image processing, or text control.

The input/output interface **150** may include various input/output circuitry and function as an interface that transfers instructions or data input from a user or another external device to the other element(s) of the electronic device **101**, and may output the instructions or data received from the other element(s) of the electronic device **101** to the user or an external electronic device.

The display **160** may include a liquid crystal display (LCD), a light emitting diode (LED) display, an organic LED (OLED) display, a micro electro mechanical system (MEMS) display, or an electronic paper display, but is not limited thereto, may display various types of content, such as text, images, videos, icons, or symbols, and may display a web page.

The display **160** may include a touch screen, which receives a touch, a gesture, proximity, or a hovering input, using an electronic pen or a user's body part, such as a finger.

The communication interface **170** may include various communication circuitry and establish communication between the electronic device **101** and a first external electronic device **102**, a second external electronic device **104**, and/or a server **106**. For example, the communication interface **170** communicates with the first external electronic device **102**, the second external electronic device **104**, and/or the server **106** through the network **162** using wireless communication or wired communication or via a short-range communication **164**. For example, the wireless communication conforms to a cellular communication protocol including at least one of LTE, LTE-advanced (LTE-A), code division multiple access (CDMA), wideband code division multiple access (WCDMA), universal mobile telecommunication system (UMTS), wireless broadband (WiBro), and GSM.

The wired communication may include at least one of a universal serial bus (USB), a high definition multimedia interface (HDMI), a recommended standard 232 (RS-232), and a plain old telephone service (POTS).

The network **162** may include a telecommunications network, a computer network such as local area network (LAN) or wide area network (WAN), the Internet, and a telephone network.

The electronic device **101** may provide an LTE service in a single radio environment by use of at least one module functionally or physically separated from the processor **120**.

Each of the first and second external electronic devices **102** and **104** may be the same or different type of device as the electronic device **101**.

The server **106** may include a group of one or more servers.

All or some of the operations to be executed by the electronic device **101** may be executed by the first external electronic device **102**, the second external electronic device **104**, and/or the server **106**. For example, when the electronic device **101** performs a certain function or service automatically or by request, the electronic device **101** may request some functions that are associated therewith from the first external electronic device **102**, the second external electronic device **104**, and/or the server **106**, instead of or in addition to executing the function or service itself The first external electronic device **102**, the second external electronic device **104**, and/or the server **106** may execute the requested functions or additional functions, and may transmit the results to the electronic device **101**, which then provides the requested functions or services by processing the received results. For example, a cloud, distributed, or client-server computing technique may be used.

According to embodiments, the processor **210** may determine a current mode of the electronic device based on a result detected in at least one of the above-described sensor modules, may generate a control signal based on the determined current mode, and may adjust an operating frequency band of a conductive member of the electronic device in a low band by controlling a tunable circuit using the corresponding control signal.

FIG. **2** illustrates an electronic device, according to an embodiment of the present disclosure.

Referring to FIG. **2**, the electronic device **201** includes a processor **210**, a communication module **220**, a subscriber identification module (SIM) card **224**, a memory **230**, a sensor module **240**, an input device **250**, a display **260**, an interface **270**, an audio module **280**, a camera module **291**, a power management module **295**, a battery **296**, an indicator **297**, and a motor **298**.

The processor **210** may include various processing circuitry and control a plurality of hardware or software elements connected to the processor **210** by driving an OS or an application program, may process multimedia data, perform arithmetic operations, may be implemented with a system on chip (SoC), and may further include a GPU.

The communication module **220** may include various communication circuitry and perform data transmission/reception between an external electronic device and/or a server, which may be connected with the electronic device through a network. Such circuitry, includes a cellular module **221**, a Wi-Fi module **223**, a Bluetooth® (BT) module **225**, a global navigation satellite system (GNSS) or GPS module **227**, a near field communication (NFC) module **228**, and a radio frequency (RF) module **229**.

The cellular module **221** may provide a voice call, a video call, a text service, or an Internet service through a communication network, such as LTE, LTE-A, CDMA, WCDMA, UMTS, WiBro, or GSM, may identify and authenticate the electronic device within the communication network by using the SIM card **224**, and may perform at least some of the functions that can be provided by the processor **210**, such as multimedia control functions.

The cellular module **221** may include a CP and may be implemented with an SoC. Although elements, such as the cellular module **221**, the memory **230**, and the power management module **295** are illustrated as separate elements with respect to the processor **210** in FIG. **2**, the processor **210** may also be implemented such that at least one of the aforementioned elements is included in the processor **210**.

The processor **210** or the cellular module **221** may load an instruction or data, which is received from each non-volatile memory connected thereto or at least one of different elements, to a volatile memory, may process the instruction or data, and may store data, which is received from at least one of different elements or generated by at least one of different elements, into a non-volatile memory.

Each of the Wi-Fi module **223**, the BT module **225**, the GNSS module **227**, and the NFC module **228** may include a processor for processing data transmitted/received through a corresponding module. Although the cellular module **221**, the Wi-Fi module **223**, the BT module **225**, the GNSS module **227**, and the NFC module **228** are illustrated in FIG. **2** as separate blocks, at least two of these modules may be included in one integrated chip (IC) or IC package. For example, at least two of processors corresponding to the

modules, such as a communication processor corresponding to the cellular module **221** and a Wi-Fi processor corresponding to the Wi-Fi module **223**, may be implemented with an SoC.

The RF module **229** may transmit/receive data, such as an RF signal, may include a transceiver, a power amp module (PAM), a frequency filter, or a low noise amplifier (LNA), and may further include a component for transmitting/receiving a radio wave on a free space in wireless communication, such as a conductor or a conducting wire. At least one of the above modules may transmit/receive an RF signal via a separate RF module.

The SIM card **224** may be inserted into a slot formed in the electronic device and includes unique identification information, such as an integrated circuit card identifier (ICCID) or subscriber information, such as an international mobile subscriber identity (IMSI).

The memory **230** includes an internal memory **232** and/or an external memory **234**.

The internal memory **232** may include at least one of a volatile memory, such as a dynamic random access memory (DRAM), a static RAM (SRAM), or a synchronous dynamic RAM (SDRAM) or a non-volatile memory, such as a one-time programmable read only memory (OTPROM), a programmable ROM (PROM), an erasable and programmable ROM (EPROM), an electrically erasable and programmable ROM (EEPROM), a mask ROM, a flash ROM, a not and (NAND) flash memory, and a not or (NOR) flash memory, and may be a solid state drive (SSD).

The external memory **234** may include a flash drive, a compact flash (CF), secure digital (SD), micro-SD, mini-SD, extreme digital (xD), and a memory stick, and may be operatively coupled to the electronic device via various interfaces.

The electronic device may also include a storage unit (or a storage medium), such as a hard drive.

The sensor module **240** may measure a physical quantity or detect an operation state of the electronic device, and convert the measured or detected information into an electrical signal. The sensor module **240** includes a gesture sensor **240**A, a gyro sensor **240**B, an atmospheric pressure sensor **240**C, a magnetic sensor **240**D, an acceleration sensor **240**E, a grip sensor **240**F, a proximity sensor **240**G, a color sensor **240**H, such as a red, green, blue (RGB) sensor, a biometric sensor **240**I, a temperature/humidity sensor **240**J, an illumination sensor **240**K, and an ultraviolet (UV) sensor **240**M.

Additionally or alternatively, the sensor module **240** may include an E-node sensor, an electromyography (EMG) sensor, an electroencephalogram (EEG) sensor, an electrocardiogram (ECG) sensor, and/or a fingerprint sensor, and a control circuit for controlling at least one or more sensors included therein.

The input device **250** may include various input circuitry, such as a touch panel **252**, a (digital) pen sensor **254**, a key **256**, and an ultrasonic input unit **258**. The touch panel **252** may recognize a touch input by using at least one of an electrostatic type configuration, a pressure-sensitive type configuration, and an ultrasonic type configuration, and may further include a control circuit. When the touch panel is of the electrostatic type, both physical contact recognition and proximity recognition are possible. The touch panel **252** may further include a tactile layer, which provides the user with a tactile reaction.

The (digital) pen sensor **254** may include a recognition sheet which can be a part of the touch panel or can be separately implemented from the touch panel, and may be implemented using the same or similar method of receiving a touch input of a user or using an additional recognition sheet.

The key **256** may include a physical button, an optical key, or a keypad.

The ultrasonic input device **258** may detect ultrasonic waves generated by an input tool through a microphone **288**, may confirm data corresponding to the detected ultrasonic waves, and may detect a reflected sound wave through the microphone **288** and perform radio recognition. For example, an ultrasonic signal, which may be generated by using a pen, may be reflected off an object and detected by the microphone **288**.

The electronic device may use the communication module **220** to receive a user input from an external device, such as a computer or a server connected thereto.

The display **260** includes a panel **262**, a hologram device **264**, and a projector **266**.

The panel **262** may be an LCD or an active matrix OLED (AM-OLED) and may be implemented in a flexible, transparent, or wearable manner. Alternatively, the panel **262** may be implemented as one module with the touch panel **252**.

The hologram device **264** uses an interference of light and displays a stereoscopic image in the air.

The projector **266** displays an image by projecting a light beam onto a screen, which may be located inside or outside the electronic device.

The display **260** may further include a control circuit for controlling the panel **262**, the hologram device **264**, and/or the projector **266**.

The interface **270** may include various interface circuitry, such as an HDMI **272**, a USB **274**, an optical communication interface **276**, and a d-subminiature (D-sub) **278**, and may include a mobile high-definition link (MHL), SD/multi-media card (MMC), and/or Infrared Data Association (IrDA) standard device.

The audio module **280** bilaterally converts a sound and an electric signal, and converts sound information, which is input or output through a speaker **282**, a receiver **284**, an earphone **286**, and/or the microphone **288**.

The speaker **282** may output a signal of an audible frequency band and a signal of an ultrasonic frequency band. Reflected waves of an ultrasonic signal emitted from the speaker **282** and a signal of an external audible frequency band may be received.

The camera module **291** captures an image and/or a video, and may include one or more image sensors, such as a front sensor or a rear sensor, a lens, an image signal processor (ISP), or a flash, such as an LED or a xenon lamp. Alternatively, the electronic device may include two or more camera modules.

The power management module **295** manages power of the electronic device and may include a power management integrated circuit (PMIC), a charger IC, and/or a battery gauge.

The PMIC may be included in an IC or an SoC semiconductor and may use a wired charging and/or a wireless charging method. The charger IC may charge the battery **296** and may prevent an over-voltage or over-current flow.

Different types of wireless charging may include magnetic resonance, magnetic induction, and electromagnetic types. An additional circuit for the wireless charging, such as a coil loop, a resonant circuit, and/or a rectifier may be added.

The battery gauge may measure a residual quantity of the battery **296** and a voltage, current, and temperature during charging. The battery **296** stores or generates electricity and

supplies power to the electronic device by using the stored or generated electricity, and may include a rechargeable battery or a solar battery.

The indicator **297** indicates a specific state, such as a booting state, a message, or a charging state of the electronic device or a part thereof, such as the processor **210**.

The motor **298** converts an electric signal into a mechanical vibration.

Alternatively, the electronic device includes a processing unit, such as a GPU, for supporting mobile TV, which processes media data according to a protocol such as digital multimedia broadcasting (DMB), digital video broadcasting (DVB), and/or media flow.

According to embodiments, a processor **210** may control a display **260** in order to display an integrated image on a first region, such as a flat portion, and at least one second region, such as a bent portion of the display **260**. The processor **210** may include a DDI for controlling the display **260**, and a touch driver IC (TDI) when the display **260** is used as a touch screen device. For a received raw image, the processor **210** may scale corresponding images so as to have respective corresponding resolutions based on the resolution corresponding to the flat portion of the display **260** and the resolution corresponding to the bent portion of the display **260**, and may control the DDI such that a processed image can be optimized as one image and displayed on the display **260**. However, the present disclosure is not limited thereto, and the operations described above may be performed directly by the DDI without intervention from the processor **210**, or may be performed directly by the processor **210**.

According to embodiments, the processor **210** may deform corresponding images such that the corresponding images have respective corresponding resolutions based on the resolution corresponding to the flat portion of the display **260** and the bent region of the display **260** among row images accommodated through a software program stored in the memory **230**, and may perform control such that a deformed image may be optimized as one image and displayed on the display **260**.

In the present disclosure, the input unit is illustrated and described as being at least partially exposed to the outside of the electronic device through the display. However, the present disclosure is not limited thereto, and the input unit may include at least one of a speaker device, a microphone device, a camera device, various sensor devices, an interface connector device, a flash device, and an external card storage device.

Each of the above-described component elements of hardware according to the present disclosure may be configured with one or more components, and the names of the corresponding component elements may vary based on the type of electronic device. The electronic device according to embodiments of the present disclosure may include at least one of the aforementioned elements. Some elements may be omitted or other additional elements may be further included in the electronic device. Also, some of the hardware components according to embodiments may be combined into one entity, which may perform functions identical to those of the relevant components prior to the combination.

FIG. **3**A is a perspective view illustrating an electronic device according to embodiments of the present disclosure. FIG. **3**B is a plan view of the electronic device according to embodiments of the present disclosure. FIG. **3**C is a rear side perspective view of the electronic device according to embodiments of the present disclosure.

Referring to FIGS. **3**A, **3**B and **3**C, the electronic device **300** may include a housing **310** formed of a conductive member and/or a non-conductive member. The display **301** includes a window, such as a front window or a glass plate, may be disposed on a first face **3001**, such as the front face of the housing **310**, may include a touch sensor so as to operate as a touch screen device, and may further include a pressure sensor so as to operate as a pressure-responsive touch screen device. The electronic device **300** may include a receiver **302**, which is disposed in the housing **310** so as to output the voice of a communication partner, and a microphone device **303**, which is disposed in the housing **310** so as to transmit the user's voice to the communication partner.

The electronic device **300** may include various components, which are exposed in the display **301**, or are not exposed, in order to perform various functions of the electronic device **300**. The components may include at least one sensor module **304** such as an illuminance sensor, a proximity sensor, an infrared sensor, an ultrasonic sensor, a fingerprint recognition sensor, or an iris recognition sensor, may include a front camera device **305**, and an indicator, such as a light emitting diode (LED), configured to enable a user to recognize status information of the electronic device.

A speaker **308** may be disposed at one side of the microphone device **303**, and an interface connector port **307** may be disposed at the other side of the microphone device **303** in order to receive a data transmission/reception function by an external device and external power to charge the electronic device **300**. An ear jack hole **309** may be disposed at one side of the interface connector port **307**.

In the display **301**, substantially the entire first face **3001** of the electronic device **300** and a portion of a side face **3002** or a second face **3003** including the side face **3002** may be defined as a display region. In this case, the above-described electronic components may be disposed by performing the functions thereof within the electronic device through the display **301** (or a window) or by being exposed to the housing **310** other than the display region.

The electronic device **300** may include a rear window **311** disposed on the second face **3003**, such as the rear face, opposite the first face **3001** of the housing **310**, and may include a rear camera device **312** disposed on the second face **3003** and at least one electronic component **313** disposed on one side of the rear camera device **312**. The electronic components **313** may include at least one of an illuminance sensor, a proximity sensor, an infrared sensor, an ultrasonic sensor, a heart rate sensor, a flash device, and a fingerprint recognition sensor.

The display **301** may include a flat portion **3011**, and one or more bent regions **3012** and **3013** extending from the flat portion **3011** in a manner of being bent to a side face. The one or more bent portions may include a first bent portion **3012** bent to the right side face from the flat portion **3011** and a second bent portion **3013** bent from the flat portion **3011** to the left side face. However, the present disclosure is not limited thereto, and the display may include a bent portion that is bent to the upper side face from the flat portion **3011** or bent to the lower side face.

At least one of respective bent portions **3012** and **3013** may be bent by extending to at least a portion of the side face **3002** of the housing **310** or to at least a portion of the second face **3003** through the side face **3002** of the housing **310**. The respective bent portions **3012** and **3013** may have the same curvature or different curvatures, and may be formed to have different bent regions.

According to embodiments, the electronic device **300** may include therein an input unit **320**, at least a portion of

which is exposed to the exterior of the electronic device **300** through at least one bent portion, and at least part of the input unit **320** may be exposed to the outside of the electronic device **300** to accommodate the user's operation.

The electronic device **300** may include a display module that is arranged to enable data input/output to a region including a flat portion and at least one bent portion of the display **301**, and includes a flexible display panel (film), a touch panel (film), and/or a pressure-responsive sensor pad. The display **301** may be formed in a manner such that the top face and the rear face are simultaneously bent in a 3D manner, and may include a transparent glass material, such as sapphire glass, or a transparent synthetic resin window.

According to embodiments, the electronic device **300** may control the display **301** so as to selectively display information, to configure an input/output screen only on the flat portion **3011**, to configure an input/output screen including one or more bent portions **3012** and **3013** together with the flat portion **3011**, and to configure an input/output screen with only one or more bent portions **3012** and **3013**, excluding the flat portion **3011**.

When assembled into the electronic device **300**, the input unit **320** may be arranged such that only a portion of the input unit **320** is exposed through a portion of the display region of the display **301**. In order to induce manipulation of the input unit **320**, the electronic device **300** may visually display a corresponding object around the input unit **320**, which is exposed to one or more bent portions **3012** and **3013** of the display region of the display **301**, and may adjust the resolution of the bent portion including the input unit **320** so as to display an image together with the flat portion.

FIG. **4** is an exploded perspective view of an electronic device according to an embodiment of the present disclosure.

Referring to FIG. **4**, the electronic device **400** may include a housing **410** and a display **440** disposed on the upper portion of the housing **410**, and may further include a battery **451**, a substrate **450**, and a rear cover **470**, which are sequentially disposed in the lower portion the housing **410**. The electronic device **400** may include an input unit **460**, which is disposed in the housing **410** and is installed in such a manner that at least a portion of the electronic device **400** is exposed to the outside of the electronic device **400** through at least a portion of the display **440**.

The display **440** may include a window **430**, which forms the outward appearance of the electronic device **400** and a display module **420**, which is attached to the rear face of the window **430**. The display module **420** is formed of a flexible material, and is bonded to the rear face of the window **430** by an adhesive member **4001** while being preliminarily pressurized by a guide film disposed generally in an upper portion (on the window side) of the display module **420**, which ensures smooth bonding even in the bent regions of the window **430**.

The window **430** includes a first bent portion **4302** bent from the flat portion **4301** to the right side face and a second bent portion **4303** bent to the left side face from the flat portion **4301**. However, only one of the first bent portion **4302** and the second bent portion **4303** may be disposed, or additional bent portions may be disposed. The window **430** may include a through hole **4304** formed in the first bent portion **4302**. The through hole **4304** may guide a portion of the key button **462** of the input unit **460** to pass therethrough. The window **430** may include a separate structure, such as a strip of metal or a print, which is disposed along the perimeter of the through hole **4304**.

The display module **420** may include a flat portion **4201** disposed at a position corresponding to the flat portion **4301** of the window **430**, a first bent portion **4202** disposed in the flat portion **4201** at a position corresponding to the first bent portion **4302** of the window **430**, and a second bent portion **4203** disposed at a position corresponding to the second bent portion **4303** of the window **430** in the flat portion **4201**. The display module **420** may include an opening **4204** formed in the region of the first bent portion **4202** corresponding to the through hole **4304** of the window **430**, i.e., in a groove shape at an end of the display module **420**, or may be formed in the display region in the through hole **4304** of the window **430**.

The housing **410** may include a conductive member and a non-conductive member, and may be formed such that the non-conductive member is coupled to the conductive member through an insert injection molding process or a dual injection molding process. However, the present disclosure is not limited thereto, and the housing **410** may be formed such that the conductive member and the non-conductive member are structurally coupled to each other by a piece of adhesive tape or bonding.

The housing **410** may include a flat portion **4101** disposed at a position corresponding to the flat portion **4301** of the window **430**, a first bent portion **4102** disposed in the flat portion **4101** at a position corresponding to the first bent portion **4302** of the window **430**, a second bent portion **4103** disposed at a position corresponding to the second bent portion **4303** of the window **430** in the flat portion **4101**, and an opening **4104**, which accommodates the input unit **460** in at least a portion therein and guides at least a portion of the key button **462** of the input unit **460** to be exposed to the outside of the electronic device **400** through the opening **4204** of the display **420** and the through hole **4304** of the window **430**.

The input unit **460** may include a key button **462** and a terminal piece **463**, such as an electrical product of a key, fixed to the key button **462**. The key button **462** is movably fixed within a key accommodation space separately provided in the housing **410**, and may be disposed by being electrically connected to a metal bracket **461** fixed to a conductive connection region, which is electrically connected to a substrate disposed in the space. The terminal piece **463** may include a substrate having a pressure sensor, may sense pressure by the pressing operation of the key button **462**, and may provide sensed information to the substrate. According to one embodiment, at least the portion of the key button **462** that is disposed on the electronic device may be formed of the same material as the window **430** for aesthetic purposes. However, the present disclosure is not limited thereto, and the key button **462** may be formed of a material, such as a metal member, a polycarbonate (PC), or a fiber material, which is different from the window **430**.

The substrate **450** may be disposed in the inner space of the housing **410**, and the battery **451** may be disposed alongside the substrate **450**. However, the present disclosure is not limited thereto, and the battery **451** may be disposed in a manner overlapping at least a portion of the substrate **450**.

The rear cover **470** may be disposed in a manner of being attached to the housing **410**, may be formed of a glass, metal, or synthetic resin material, and may be disposed by being attached to the housing **410** by an adhesive member, such as a waterproofing sealing member.

FIGS. **5**A and **5**B illustrate when an input unit is applied to a bent display according to embodiments of the present disclosure.

Referring to FIG. **5**A, the electronic device **510** includes a display **514** disposed in such a manner that the display module **512** is attached to the rear face of the window **513**, and a housing **511** to which the display **514** is coupled. The display **514** may include a flat portion **5101** and a bent portion **5102** extended to be bent from the flat portion **5101** with a predetermined curvature. The housing **511** may include a key accommodation space **5111** disposed to include at least a portion of an inner region or cavity formed by the bent portion **5102** of the display **514**.

The key accommodation space **5111** may be formed integrally with the housing **511**, and may be formed as a hermetically closed space except for a region, through which the key button **517** passes, for waterproofing purposes. Accordingly, the input unit **517** may be provided in the key accommodation space **5111**, which is separately provided in the housing **511**, and may be disposed such that at least a portion of the input unit **517** is exposed through the display **514**.

Referring to FIG. **5**B, an electronic device **520** may include a display **524** disposed such that a display module **522** is attached to the rear face of a window **523**, and a housing **521**, to which the display **524** is coupled. The display **524** may include a flat portion **5201** and a bent portion **5202** extend to be bent from the flat portion **5201** with a predetermined curvature. A cavity region **525** may be formed between the bent portion **5202** of the display **524** and the housing **521**, a separate filler **526** may be disposed in the cavity region **525**, and an input unit **527** installed through the filler **526** may be disposed by penetrating the display module **522** and the window **523** of the display **524**.

FIG. **6**A is a cross-sectional view of an electronic device, to which an input unit according to embodiments of the present disclosure is applied.

Referring to FIG. **6**A, the electronic device **600** may include a display **620** including a flat portion **6202** and a bent portion **6203** extending from the flat portion **6202** with a predetermined curvature, a housing **610** in which the display **620** is mounted, and an input unit **640** disposed in the key accommodation space **6102** provided in the housing **610** so as to be at least partially exposed to the outside of the electronic device **600** through the housing **610** and the display **620**. The electronic device **600** may further include a rear cover disposed on the rear face of the housing **610**.

The display **620** may include a window **621** and a display module **622**, which is attached to the rear face of the window **621**. The bent portion **6203** may extend to at least a portion of a side face of the electronic device **600** or at least a portion of the rear face through the side face.

A seal member for waterproofing and dustproofing may be disposed between the display module **622** and the housing **610** so as to prevent moisture and foreign matter from being introduced through the display **620**, and is also disposed for waterproofing and dustproofing in the entire electronic device **600** between the rear cover and the housing **610**.

The housing **610** may include a separate key accommodation space **6102** formed to be spaced apart from the inner space **6101** where a substrate **680** is mounted. However, the inner space **6101** and the key accommodation space **6102** may be formed by the structural shape of the single housing **610**. An input unit **640** may be disposed such that a key top **6411** of the input unit **640** penetrates from the inside of the key accommodation space **6102** to the outside and a key base **6412** disposed to extend from an end of the key top **6411** is secured inside the key accommodation space **6102**.

A terminal piece **642** may be disposed at an end of the key base **6412** and may include a pressure-sensitive substrate. However, the present disclosure is not limited thereto, and the terminal piece **642** may include a substrate, on which a metal dome is mounted to perform a switching operation by a physical pressing operation. The terminal piece **642** may be disposed to be in physical contact with a metal bracket **614**, such as a connection terminal, disposed in the key accommodation space **6102** of the housing **610**.

The housing **610** may be formed through a double injection molding of a conductive member **611** and a non-conductive member **612**. When the display **620** is installed in the housing **610**, the region where the bracket **614** is disposed may be formed of the non-conductive member **612**. The bracket **614** may be fixed to the conductive connection region **613** disposed in the non-conductive member **612**. The conductive connection region **613** may be maintained as insulated from the conductive member **611** by the non-conductive member **612**, may be formed of the same metal material as the conductive member **611** or may be formed of a metal material different from that of the conductive member **611**, and may be formed of the same material as the metal bracket **614**, which is in contact with and/or fixed to the conductive connection region **613**, in consideration of galvanic corrosion or the like. The metal bracket **614** may include a resilient spring contact or a pogo pin.

A substrate **680** may be disposed in the inner space **6101** of the housing **610**. The connection terminal **681** may be mounted on the substrate **680**, and may be maintained in physical contact with the conductive connection region **613** disposed in the boundary portion with the key accommodation space **6102** in the inner space **6101**. Accordingly, the terminal piece **642** of the input unit **640** may be electrically connected to the substrate **680** through the bracket **614** disposed in the key accommodation space **6102** of the housing **610** and attached to the conductive connection region **613**; the conductive connection region **613**, and the connection terminal **681** disposed in the inner space **6101** of the housing **610**.

The input unit **640**, which is disposed in the key accommodation space **6102** formed separately from the inner space **6101** of the housing **610**, may be electrically connected to the substrate **680**, which is disposed in the inner space **6101** without passing through a separate open portion of the housing **610**. Such a configuration is advantageous for implementing a waterproof/dustproof structure preventing moisture from permeating into the internal space **6101** of the housing **610** even if the moisture is introduced through a through hole **6204** in the display **620**.

At least one adhesive member **6201** for attaching the display module **622** and the window **621** to each other may be disposed between the display module **622** and the window **621**. The adhesive member **6201** may include an optically clear resin (OCR) **7001** or an optical clear adhesive (OCA) **7002**. When the bent portions of the display module **622** and the bending portion of the window **621** are formed to have different curvatures, the adhesive member between the display module **622** and the window **621** may be applied with different thicknesses.

FIG. **6**B is a perspective view of a main part, which illustrates the configuration of the housing **610** of FIG. **6**A, according to embodiments of the present disclosure.

Referring to FIG. **6**B, the housing **610** including a flat portion **6103** and a bent portion **6104** extending from the flat portion **6103** with a predetermined curvature. The housing **610** may include an inner space **6101** for accommodating the substrate **680** and a key accommodation space **6102** for

accommodating an input unit **640**. The inner space **6101** is sealed from the outside by the rear cover **650**. The key accommodation space **6102** may be formed as a closed cavity, and may include a key penetration hole **6105** formed from the key accommodation space **6102** to a outer surface of the bent portion **6104** so as to enable the input unit **640** disposed in the key accommodation space **6102** to pass through the key penetration hole **6105**.

FIG. **6**C is a perspective view illustrating when an input unit is mounted on the housing of FIG. **6**A, according to embodiments of the present disclosure.

Referring to FIG. **6**C, the input unit **640** may be inserted from the outside of the housing **610** through a key penetration hole **6105**, which is formed in the key accommodation space **6102** of the housing **610**, and then fixed. The input unit **640** is fixed within the key accommodation space **6102** and may be exposed to the outside of the electronic device **600** through the key penetration hole **6105** and the through hole **6204** in the display **620** of the electronic device **600**.

Since the key penetration hole **6105** is formed to have a size capable of accommodating up to a key base **6412** having a substantially larger area than the key top **6411**, a separation prevention piece **660** may be further provided for closing a region remaining after the input unit **640** is mounted in the key penetration hole **6105**. The separation prevention piece **660** may be formed of at least one of a metal member, a rubber member, a silicon member, a urethane member, and a PC. When a portion of the input unit **640** penetrates through the key penetration hole **6105** and the separation prevention piece **660** is fixed, the input unit **640** is inserted into the key accommodation space **6102** of the housing **610** so that the input unit **640** can be restrained and prevented from being separated to the outside from the key accommodation space **6102** of the housing **610**.

FIGS. **7**A and **7**B are cross-sectional views of a main part, which illustrates the assembly state of a display according to embodiments of the present disclosure.

The bent portions of the display module of the display and the window may be formed to have the same curvature as described above. However, when the bent portions of the display module and the window are formed to have different curvatures, a compensating unit for compensating for a gap formed between the display module and the window may be provided.

Referring to FIG. **7**A, an electronic device **700** may include a housing **710**, a display **720** disposed in the upper portion of the housing **710**, and a rear cover **730** disposed in the lower portion of the housing **710**. The display **720** may include a window **721** and a display module **722**, which is disposed on the rear face of the window **721**. The window **721** may include a flat portion **7211** and a bent portion **7212** formed to extend from the flat portion **7211** with a first curvature. The display module **722** may include a flat portion **7221** and a bent portion **7222** formed to extend from the flat portion **7221** with a second curvature. The first curvature and the second curvature may be different from each other, such that the second curvature may be larger than the first curvature.

Since the respective bent portions **7212** and **7222** of the window **721** and the display module **7221** in the display have different curvatures, cavities **7003** may be formed in the corresponding regions, and one or more optical adhesive members **7001** and **7002** may be attached to and filled in the cavities. At least one optical adhesive member may include an OCR **7001** or an OCA **7002**.

As illustrated, the window and display module are attached to each other by the OCA, and the cavities may be filled with the OCR. However, the present disclosure is not limited thereto, and only one adhesive member of the OCR and the OCA may be used, or different adhesive members may be arranged in multiple layers.

Referring to FIG. **7**B, an electronic device **700** may include a housing **710**, a display **740** disposed in the upper portion of the housing **710**, and a rear cover **730** disposed in the lower portion of the housing **710**. The display **740** may include a window **741** and a display module **742**, which is disposed on the rear face of the window **741**. The window **741** may include a flat portion **7411** and a bent portion **7412** formed to extend from the flat portion **7411** with a first curvature. The display module **742** may include a flat portion **7421** and a bent portion **7422** formed to extend from the flat portion **7421** with a second curvature. The first curvature and the second curvature may be different from each other, a cavity, which is formed between the bent portion **7412** of the window **741** and the bent portion **7422** of the display module **742** may be compensated by the thickness T of the bent portion **7412** of the window **741**, which is formed to be thicker than other regions. In this case, the display module **742** may be attached to the rear face of the window **741** by the optical adhesive **7002**.

FIGS. **8**A and **8**B are configuration views of a display module illustrating the arrangement of signal lines according to the arrangement of an input unit according to embodiments of the present disclosure.

Referring to FIG. **8**A, an input unit **821** may be disposed to be exposed to the outside of the electronic device by penetrating at least a portion of a display module **800**, may be installed to penetrate at least a portion of the bent portions **820** and **830** of the display module **800**, and may be disposed so as to penetrate an opening **8201**, which is formed such that an edge portion of a first bent portion **820** of the display module **800** is recessed.

The display module **800** may include: a flat portion **810** (section A of FIG. **8**A), a first bent portion **820** (section B1 of FIG. **8**A) extending from one side of the flat portion **810** to be bent with a first curvature, and a second bent portion **830** (section B2 of FIG. **8**A) extending from the other side of the flat portion **810** to be bent with a second curvature. The first curvature and the second curvature may be the same as or different from each other. The electronic device may display an image through at least one of the flat portion **810**, the first bent portion **820**, and the second bent portion **830**.

The first bent portion **820**, in which the input unit **821** is disposed, may include a plurality of second signal lines S**2**, which are arranged differently from the first signal lines S**1** arranged in the flat portion **810**, by an opening **8201**, which is formed in order to accommodate the input unit **821**. The plurality of second signal lines S**2** may be arranged away from the opening **8201**. The interval between respective unit signal lines in the plurality of first signal lines S**1** arranged in the flat portion **810** may be closer than the interval between respective unit signal lines in the plurality of second signal lines S**2** arranged in the first bent portion **820**. The interval between respective unit signal lines in the plurality of second signal lines S**2** arranged in the first bent portion **820** may be twice the interval between respective unit signal lines in the plurality of first signal lines S**1**. However, the present disclosure is not limited thereto, and the interval between respective unit signal lines in the plurality of second signal lines S**2** may be determined depending on the size or shape of the opening **8201**, since

the second signal lines S2 in the first bent portion **820** are arranged away from the opening **8201**, unlike the flat portion **810**.

The second bent portion **830** may include a plurality of third signal lines S3 having the same arrangement as the plurality of second signal lines S2 of the first bent portion **820**. However, the present disclosure is not limited thereto, and since the input unit **821** does not exist in the second bent portion **830**, the third signal lines S3 may be arranged in the same manner as the plurality of first signal lines S1.

The first signal lines S1, the second signal lines S2 and the third signal lines S3 may include a plurality of electrode lines and/or data lines provided for a plurality of pixels as the constituent elements of the display module. Therefore, the image displayed on the flat portion **810** (section A) of the display module **800** may have a relatively higher resolution than that of an image displayed on the first bent section **820** (section B1).

Referring to FIG. **8**B, the input unit **822** disposed in the first bent portion **820** of the display module **800** may be exposed to the outside of the electronic device through the through hole **8202**, which is formed in the second bent portion **830**. In this case, the plurality of second signal lines S2 disposed in the first bent portion **820** may also be disposed so as to avoid the through holes **8202**. The interval of respective unit signal lines in the plurality of second signal lines S2 may be determined depending on the size or shape of the through hole **8202**.

FIG. **9**A illustrates an image optimization process by a DDI according to embodiments of the present disclosure.

An electronic device may include a DDI **910**. For a received raw image **920**, the DDI **910** may scale images of corresponding regions so as to have respective corresponding resolutions, based on a first resolution of the flat portion of a display and a second resolution corresponding to regions B1 and B2 corresponding to bent portions of the display. The DDI **910** may optimize images, which have been processed to correspond to the resolution information of respective regions A, B1, and B2, as one image **930**, and may display the image **930** on the display.

The DDI **910** may deform, by a software program stored in a memory, a received raw image **920** such that respective regions A, B1, and B2 of the image have corresponding resolutions based on corresponding resolutions, and the DDI **910** may perform control such that deformed image is manipulated into an image **930** and is displayed on the display.

FIG. **9**B illustrates a procedure for displaying an image on a flat portion and a bent portion of a display according to embodiments of the present disclosure.

According to embodiments, the present disclosure may provide an image display method for displaying an image on a display module including a flat portion and at least one bent portion.

Referring to FIG. **9**B, in step **901**, the electronic device may acquire a raw image, and a processor may acquire at least one image stored in the memory of the electronic device, such as by a camera module.

In step **903**, for the acquired raw image, the processor may determine a flat portion image to be displayed in a section corresponding to the flat portion of the display module, and may control the DDI to change the flat portion image so as to have the first resolution corresponding to the flat portion. However, the present disclosure is not limited thereto, and the acquired raw image may be directly processed by the DDI.

In step **905**, for the acquired raw image, the processor may determine a bent portion image to be displayed in a section corresponding to a bent portion of the display module, and may control the DDI to change the bent portion image to have the second resolution corresponding to the bent portion. The first resolution may be set to be higher than the second resolution by the plurality of signal lines, which are arranged so as to avoid the input unit disposed in the bent portion. For example, when the overall resolution of the raw image is 200 ppi (pixels per inch or dpi (dots per inch)), the processor may change the resolution of the section corresponding to the bent portion to 100 ppi (or dpi).

In step **907**, the processor may perform an operation of optimizing the changed flat portion image and bent portion image by the DDI. However, the present disclosure is not limited thereto, and, for a raw image received by a software program, such as an image scaling and synthesizing program stored in a memory, the processor may change and optimize corresponding images to have respective corresponding resolutions, based on a resolution corresponding to the flat portion of the display module and a resolution corresponding to a bent portion of the display module.

The processor may process the flat portion image having the first resolution and the bent portion image having the first resolution into a single image in step **907**, and may display the single image on the display module in step **909**.

FIG. **10** illustrates when various visual objects are applied around a key button through a display according to embodiments of the present disclosure.

Referring to FIG. **10**, the electronic device **1000** may include a display **1010** including a flat portion **1011** disposed on the front face of the electronic device **1000**, and a bent portion **1012** bent from the flat portion **1011** to at least a portion of a side face of the electronic device **1000** or at least a portion of the rear face of the electronic device **1000**. The bent portion **1012** may be formed to an outwardly bent shape having a predetermined curvature.

The electronic device **1000** may be provided with the key button **1020**, which is disposed to penetrates the bent portion **1012** of the display **1010** and includes at least one of a pressure-responsive structure, a physical-pressing structure including a dome key, a structure of detecting a change in capacitance, an electromagnetic induction structure, and a structure using selective energization by a piezoelectric member.

When the pressing of the key button **1020** is detected, the electronic device **1000** may display an object **1021** for providing a visual indication to a user in the peripheral region of the key button **1020** of the bent portion **1012**. The object **1021** for visual indication may include a change in the shape of a dynamically moving object or a change in the color of an object, for example.

The object for visual indication may include a change in the shape of a dynamically moving object or in the color of an object, for example.

Embodiments of the present disclosure are capable of smoothly displaying an image through a region even if an input unit is exposed through a bent display. Also, since the input unit is exposed through the display, the convenience in using the input unit is enhanced, and device aesthetics and grip feel are also enhanced by the bent display.

According to embodiments of the present disclosure, an electronic device includes a housing including a first face, a second face facing away from the first face, and a side face surrounding a space between the first face and the second face, a display mounted on the housing and including a flat portion substantially corresponding to the first face and a

bent portion extending in a lateral direction from the flat portion, at least one input unit disposed between the bent portion of the display and the housing and at least partially exposed outwardly through at least a portion of the bent portion, a detection circuit disposed inside the housing and electrically connected to the input unit, the detection circuit being configured to detect an operation of the input unit, and at least one processor functionally connected to the detection circuit and the display and configured to perform control so as to cause the electronic device to perform a corresponding function according to a received detection signal. An interval of unit signal lines in a plurality of first signal lines arranged on the flat portion of the display is different from an interval of unit signal lines in a plurality of second signal lines disposed in the bent portion.

The second signal lines may be arranged away from a portion which is penetrated by the input unit in the bent portion.

The interval between the unit signal lines in the first signal lines may be closer than the interval between the unit signal lines in the second signal lines.

The first signal lines and the second signal lines may include an electrode line or a data line for a pixel.

The housing may include a closed accommodation space formed to extend in a position corresponding to the bent region, and the input unit may be disposed in the accommodation space, and may be partially penetrated through a through hole formed in the accommodation space.

The housing may be formed by a double injection molding process using a non-conductive member and a conductive member, and a boundary region between an inner space of the housing and the accommodation space may include a conductive connection region formed to be insulated from the conductive member therearound by the non-conductive member. The at least one input unit may be electrically connected to the conductive connection region in the accommodation space of the housing.

The conductive connection region may be electrically connected to the detection circuit inside the housing.

The display may include a window and a display module arranged on the rear face of the window.

An exposed portion of the at least one input unit may be exposed through an opening or through hole formed in at least a portion of a region corresponding to the bent portion of the display module and through the window.

The bent region of the display module may be formed to have a curvature larger than a curvature of the bent region of the window.

The electronic device may further include at least one adhesive member formed in at least one layer and disposed in a space formed between the bent region of the display module and the bent region of the window.

The at least one adhesive member may include an OCA or an OCR.

The at least one input unit may include at least one of a speaker device, a microphone device, a camera device, various sensor devices, an interface connector device, a flash device, and an external card storage device.

The at least one input unit may include at least one of a pressure-responsive structure, a physical-pressing structure including a dome key, a structure of detecting a change in capacitance, an electromagnetic induction structure, and a structure using selective energization by a piezoelectric member.

According to embodiments of the present disclosure, a method of displaying an image of an electronic device that includes a display having a flat portion and at least one bent portion bent from the flat portion with a predetermined curvature includes acquiring a raw image corresponding to an entire region of the display, determining a first image corresponding to the flat portion in the acquired raw image, determining a second image corresponding to the bent portion in the acquired raw image, synthesizing the determined first image and second image, and displaying a synthesized image on the display.

The method may further include changing the first image to an image having a first resolution, and changing the second image to an image having a second resolution.

The method may further include setting the first resolution to be higher than the second resolution when the input unit is exposed through at least a portion of the bent portion.

The method may further include detecting an operation of the input unit, and displaying at least one object for visual indication in a peripheral region of the input unit in the bent portion.

The at least one object for visual indication may include a change in a shape of a dynamically moving object or a change of a color of an object.

The method may further include detecting a current state of the electronic device, and displaying the at least one object for visual indication in a peripheral region of the input unit in the bent portion in order to guide a user to operate the input unit.

According to embodiments of the present disclosure, an electronic device includes a display formed in at least a portion of the electronic device, and including a first region and a second region bent at a designated angle from the first region, an input unit configured to sense a user's input through an opening formed in at least a portion of the second region of the display, and a bracket in which at least a portion of the input unit is functionally connected to a control circuit.

The first region of the display may be set to a first resolution and the second region of the display may be set to a second resolution.

The display may include at least one data line for moving at least one data for displaying an image or at least one scan line for acquiring the user's input, wherein each of the data line and the scan line is formed to be arranged differently based on a distance from the input unit.

Each of the above-described component elements of hardware according to the present disclosure may be configured with one or more components, and the names of the corresponding component elements may vary based on the type of electronic device. The electronic device according to embodiments of the present disclosure may include at least one of the aforementioned elements. Some elements may be omitted or other additional elements may be further included in the electronic device. Also, some of the hardware components according to embodiments may be combined into one entity, which may perform functions identical to those of the relevant components prior to the combination.

Embodiments of the present disclosure have been shown and described for the purpose of illustration without limiting the subject matter of the present disclosure. It should be understood by those skilled in the art that many variations and modifications of the method and apparatus described herein will still fall within the spirit and scope of the present disclosure as defined in the appended claims and their equivalents.

What is claimed is:

1. An electronic device comprising:

a window forming at least part of a front surface of the electronic device, the window including a flat portion and a bent portion, the bent portion including a through hole;

a display comprising a flat portion visible via the flat portion of the window and a bent portion visible via the bent portion of the window, the bent portion of the display including an opening aligned with the through hole;

at least one input unit passing through the through hole and the opening; and

a circuit configured to generate a signal when the at least one input unit is pressed,

wherein an interval between unit signal lines in a plurality of first signal lines arranged on the flat portion of the display is different from an interval between unit signal lines in a plurality of second signal lines disposed in the bent portion of the display.

2. The electronic device of claim 1,

wherein the second signal lines are arranged away from a portion which is penetrated by the input unit in the bent portion of the display.

3. The electronic device of claim 1,

wherein the interval between the unit signal lines in the first signal lines is closer than the interval between the unit signal lines in the second signal lines.

4. The electronic device of claim 1,

wherein the first signal lines and the second signal lines include an electrode line or a data line for a pixel.

5. The electronic device of claim 1, further comprising:

a housing including a first face, a second face facing away from the first face, and a side face surrounding a space between the first face and the second face,

wherein the housing includes a closed accommodation space formed to extend in a position corresponding to the bent portion of the display, and

wherein the at least one input unit is disposed in the accommodation space, and is partially penetrated through a through hole formed in the accommodation space.

6. The electronic device of claim 5,

wherein the housing is formed by a double injection molding process using a non-conductive member and a conductive member,

wherein a boundary region between an inner space of the housing and the accommodation space includes a conductive connection region formed to be insulated from the conductive member around the conductive connection region by the non-conductive member, and

wherein the at least one input unit is electrically connected to the conductive connection region in the accommodation space of the housing.

7. The electronic device of claim 6,

wherein the conductive connection region is electrically connected to the circuit inside the housing.

8. The electronic device of claim 1,

wherein the display includes a display module arranged on a rear face of the window.

9. The electronic device of claim 8, wherein an exposed portion of the at least one input unit is exposed through an opening or through hole formed in at least a portion of a region corresponding to the bent portion of the display module and through the through hole of the window.

10. The electronic device of claim 1,

wherein the bent portion of the display is formed to have a curvature larger than a curvature of the bent portion of the window.

11. The electronic device of claim 1, further comprising:

at least one adhesive member formed in at least one layer and disposed in a space formed between the bent portion of the display and the bent portion of the window.

12. The electronic device of claim 11,

wherein the at least one adhesive member includes an optical clear adhesive or an optical clear resin.

13. The electronic device of claim 1, further comprising:

at least one of a speaker device, a microphone device, a camera device, various sensor devices, an interface connector device, a flash device, and an external card storage device.

14. The electronic device of claim 1,

wherein the at least one input unit includes at least one of a pressure-responsive structure, a physical-pressing structure including a dome key, a structure of detecting a change in capacitance, an electromagnetic induction structure, and a structure using selective energization by a piezoelectric member.

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